Anti-satellite weapons: threats, laws and the uncertain future of space

by

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Unless otherwise noted, the conclusions expressed herein are solely those of the author writing in his personal capacity. They are not intended and should not be thought to represent official ideas, attitudes, or policies of any agency of the United States Government. The author has used only publicly-available information in the researching and presentation of this work.

And the stars of heaven shall fall, and the powers that are in heaven shall be shaken.

-- Jesus (Mark 13:25)

To my wife, Trenna, and our children,
Bryce and Raleigh

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Abstract

Satellite capabilities greatly enhance both the military and civilian sectors of society. Anti-satellite (ASAT) weapons pose a serious risk to all satellites. Chapter One of this thesis discusses current satellite capabilities. Chapter Two, details the wide variety of ASAT weapons. Chapter Three turns to the intentions of various States to employ ASATs. Chapter Four analyzes the legal implications of using force against satellites—beginning with the laws relating to the use of force in general, including the right of self-defense, and then progressing through relevant provisions of the laws of armed conflict. It also addresses the debate over the militarization and weaponization of outer space and past efforts at non-proliferation that relate to space activities. Chapter Five addresses the creation of space debris—a side effect of ASAT use. I will conclude with a short discussion regarding the potential for a new international agreement restricting the use of ASATs.

Résumé

Les possibilités satellites augmentent considérablement les secteurs militaires et civils de la société. Les armes (ASAT) antisatellite posent un risque sérieux à tous les satellites. Le chapitre un de cette thèse discute des possibilités satellites courantes. Chapitre deux, détails la large-variété d'armes d'ASAT. Le chapitre trois explique les intentions de divers états d'utiliser ASATs. Le chapitre quatre analyse les implications légales d'employer la force contre les satellite en commençant par les lois concernant l'utilisation de la force généralement comprenant les droits de l'autodéfense, progressant alors par les dispositions appropriées des lois du conflit armé. Il adresse également la discussion au-dessus de la militarisation et de l'armement de l'espace extra atmosphérique et après les efforts à la non-prolifération qui se relient aux activités de l'espace. Chapitre cinq relate la création de l'effet secondaire de débris d'espace en l'utilisant les ASAT. Je conclurai avec une discussion courte concernant le potentiel pour un nouvel accord international limitant l'utilisation d'ASATs.

Acronyms and Abbreviations

ABM	Anti-Ballistic Missile
AEHF	Advanced Extremely High Frequency Satellite Communications System
ALMV	Air-Launched Miniature Vehicle
ASAT	Anti-Satellite Weapon
BMD	Ballistic Missile Defense
COPUOS	United Nations Committee on the Peaceful Uses of Outer Space
DoD	U.S. Department of Defense
EHF	Extremely High Frequency
EMP	Electromagnetic Pulse
ENMOD	Environmental Modification Convention
EU	European Union
FY	Fiscal Year (running from 1 October of the prior year through 30 September of the listed year)
GLONASS	Global Navigation Satellite System (Russia's GNSS)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HAND	High Altitude Nuclear Detonation
ICAO	International Civil Aviation Organization
ICBM	Intercontinental Ballistic Missile
JDAM	Joint Direct Attack Munition
km	Kilometers
LOAC	Laws of Armed Conflict
MHV	Miniature Homing Vehicle (another name for ALMV)
MIRACL	Mid-Infrared Advanced Chemical Laser
NASA	U.S. National Aeronautics and Space Administration
NPOESS	National Polar-Orbiting Operational Environmental Satellite System
PAROS	Prevention of an Arms Race in Outer Space
TSAT	Transformational Satellite Communications System
UHF	Ultra High Frequency
UN	United Nations
USAF	United States Air Force
USSR	Union of Soviet Socialist Republics
WMD	Weapons of Mass Destruction

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Introduction

Orbiting the Earth at 17,000 miles per hour,[1] five hundred and thirty seven miles straight up, the Chinese weather satellite, Feng-Yun-1C (translated, "wind and cloud") exploded into thousands of pieces. On 11 January 2007, the Chinese launched a solid-fuel, medium-ranged missile at their own satellite.[2] Dubbed SC-19 by U.S. military intelligence, the missile was launched from a mobile missile launcher on the Songlin pad.[3] The Chinese tested this anti-satellite weapon (ASAT) on two prior occasions,[4] this time, however, they demonstrated they possessed the ability to destroy a satellite in Low Earth Orbit—becoming only the third State, after the U.S. and Russia, to possess this capability.

Besides showing the world it could intentionally target and destroy a satellite, China increased the risk of unintentional destruction to other satellites. Prior to impact, Feng-Yun 1C weighed about 750 kg and measured 4.6 feet on each side, with solar panels that extended about 28 feet.[5] After collision, the former Feng-Yun 1C was shattered into about 2 million pieces of debris measuring between 1 mm and 1 cm, an additional 40,000 pieces of debris measuring between 1 cm and 10 cm and another 800-

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[1] "An earth satellite in a low circular orbit, around 100 miles up, goes about 17,000 miles an hour." Thomas Karas, *The New High Ground: Strategies and Weapons of Space Age War* (New York: Simon & Schuster, Inc., 1983) at 151.

[2] Michael R. Gordon & David S. Cloud, "U.S. knew of China's missile test, but kept silent" *International Herald Tribune* (23 April 2007), online: International Herald Tribune <http://www.iht.com/articles/2007/04/23/asia/23missile.php> (accessed 6 July 2007).

[3] *Ibid.*

[4] Both prior tests (7 July 2005 and 6 February 2006) missed their targets. *Ibid.*

[5] Isenberg, David. "The Newest Anti-Satellite Contender: China's ASAT Test" (British American Security Information Council, Occasional Papers on Int'l Security Policy, 16 March 2007) at 3, online: British American Security Information Council <http://www.basicint.org/pubs/Notes/BN070316.pdf> (accessed 29 May 2007).

1,000 pieces of debris measuring over 10 cm.[6] All of this debris, orbiting at speeds up to 29,400 miles per hour—up to 17 times the speed of a bullet fired from a machine gun[7]—and a large part of this debris will remain in orbit for decades.[8] The debris created by this test increased the risk of collision with 300 satellites belonging to 24 different States and one intergovernmental organization.[9]

This thesis will address the wide range of legal issues surrounding ASAT use. In Chapter One, I will address the variety of current satellite capabilities and uses—demonstrating the tremendous importance of satellites to States. I will divide satellites into the broad categories of communications satellites, reconnaissance and remote-sensing satellites, navigation satellites, meteorological (weather) satellites, research satellites and manned space missions. I also address both the military and civilian uses of each of these categories of satellites.

Chapter Two will address past, present and future ASAT weapons. These weapons will be discussed, not in chronological order, nor by the State that possesses the discussed ASAT, but rather by the type of ASAT system—nuclear, kinetic energy (explosive), laser and other directed energy weapons, electronic jamming and finally, the inherent capabilities a ballistic missile defense system possesses for use as an ASAT. I

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[6] David Wright, "Debris from China's Kinetic Energy ASAT Test" (May 1007), online: Union of Concerned Scientists <http://www.ucsusa.org/global_security/space_weapons/debris-from-chinas-asat-test.html> (accessed 2 July 2007).

[7] "Space Debris Spotlight" (29 August 2006), online: European Space Agency <http://www.esa.int/esaCP/SEMHDJXJD1E_FeatureWeek_0.html> (accessed 29 May 2007).

[8] Wright, *supra* note 6.

[9] Union of Concerned Scientists, "Dossier: Satellites Under Threat", online: (2007) 1:1 MilSatMagazine.com at 5 <http://www.milsatmagazine.com/2007/milsatmagazine_q1.pdf> (accessed 9 July 2007).

will then tie Chapters One and Two together by addressing the vulnerability of satellites posed by the various ASAT systems.

Chapter Three will analyze a variety of indications that the United States, China and Russia intend to use ASATs. The focus will be on the United States—largely because it is the most transparent of the States with the ability to launch an ASAT weapon, and hence the majority of available information on the subject deals with U.S. programs. This thesis will delve into U.S. military doctrine, the recent and prior U.S. national space policies and other indications from Congress and U.S. Presidents of the intention to use ASAT weapons. Some analysis will then be given to indications that both China and Russia intend to use ASATs—including the most obvious of all—China's 11 January 2007 ASAT test. This chapter will also address the potential for terrorist organizations to employ ASAT weapons.

Chapter Four, will probe the military uses of space. Beginning with the Charter of the United Nations, I will address its ban on both the use of force and the threat of using force, and the controversially-applied exception for self-defense. I will address the applicability of the Laws of Armed Conflict (LOAC) to activities in space, including issues of targeting civilian satellites or incidentally damaging satellites owned by States not involved in a conflict (neutral States). From there I will discuss the "peaceful" use of space (and the debate over what that means—"non-aggressive" or "non-military"). Finally, I will address international non-proliferation treaties and how they relate to ASATs (i.e., the *Limited Nuclear Test Ban Treaty*, the *Nuclear Non-Proliferation Treaty* and the *Anti-Ballistic Missile Treaty*).

Chapter Five will turn to a problematic consequence of ASAT use—space debris. I will discuss State liability for damage caused by debris in both space and on Earth. I will also address the requirement that States give "due regard" to the outer space activities of other States and the requirement to enter into "appropriate international consultations" prior to intentionally creating debris in space. Finally, I will address the impact of the *Environmental Modification Convention* (ENMOD) on ASAT use.

Chapter Six will address the desirability of a treaty restricting ASATs and the prospects for such a treaty. I will conclude with a few conclusions and recommendations.

Chapter One: Various Uses of Satellites

Before launching into an analysis of ASAT capabilities and the legal implications that accompany their use, it is important to first turn to the current uses of satellites, the many objects orbiting the Earth.[10] Without addressing "what's up there," analyzing their premature destruction would have little meaning.

The first man-made satellite to orbit the Earth was Sputnik I, launched by the USSR on 4 October 1957.[11] It had no purpose other than to show its own existence in Earth's orbit via a small radio transmitter.[12] Since that time, there have been over 4,700 space launches.[13] Approximately 3,000 satellites have been launched into space.[14] Of the 192 States that are members of the United Nations,[15] only eight have successfully launched their own satellite.[16] Another 33 States own satellites that were launched into

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[10] A satellite is merely a "celestial object which orbits a larger one." *The New Shorter Oxford English Dictionary*, 5th ed., *s.v.* "satellite". Interestingly, the word comes from the Latin word "satellitis" meaning "bodyguard." Michel Bourbonnière, "Law of Armed Conflict (LOAC) and the Neutralisation of Satellites or *Ius in Bello* Satellitis" (2004) 9:1 J. Confl. & Sec. L. 43 at 43.

[11] Clayton K.S. Chun, *Defending Space: US Anti-Satellite Warfare and Space Weaponry* (Oxford: Osprey Publishing, 2006) at 7 [Chun, *Defending Space*].

[12] Berndt Feuerbacher, "Space Utilization" in Berndt Feuerbacher & Heinz Stoewer, eds., *Utilization of Space: Today and Tomorrow* (Heidelberg: Springer, 2006) 3 at 8. The USSR described the purpose of Sputnik I as "physical study of the atmosphere" when it registered Sputnik I with the United Nations. UN Doc. A/AC.105/INF.002 (1962).

[13] Tamar A. Mehuron, "2006 Space Almanac: The US military space operation in facts and figures" *Air Force Magazine* (August 2006) 68, 76 [Mehuron, "Space Almanac"].

[14] *Ibid.*

[15] "United Nations Member States" online: United Nations <http://www.un.org/members/list.shtml> (accessed 9 July 2007).

[16] States capable of launching their own satellites into orbit include: the United States, Russia, the United Kingdom, France, Japan, Israel, India and China. Heinz Stoewer, "Access to Space—the Prerequisites for Space Utilization" in Feuerbacher & Stoewer, *supra* note 12, 23 at 24-26.

space by one of the eight States capable of launching satellites.[17] Of approximately 3,000 satellites that have been launched, about 847 are still operational.[18]

Determining an accurate number of active satellites is difficult. There are a few reasons for this difficulty. First, though the United Nations maintains a registry of space objects,[19] and though "space objects" is a broad term that encompasses all man-made satellites and parts thereof,[20] not all satellites are registered. Only 45 States have ratified the *Registration Convention* and another four have signed it, so the majority of States are not even bound to register their space objects.[21] Of the States that currently possess

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[17] Algeria, Argentina, Australia, Brazil, Canada, Czech Republic, Denmark, Egypt, Germany, Indonesia, Iran, Italy, Kazakhstan, Luxembourg, Malaysia, Mexico, Morocco, Netherlands, Nigeria, Norway, Pakistan, Philippines, Portugal, Saudi Arabia, Singapore, South Africa, South Korea, Spain, Sweden, Taiwan, Thailand, Turkey, United Arab Emirates. UCS Satellite Database (9 April 2007), online: Union of Concerned Scientists <www.ucsusa.org/global_security/space_weapons/satellite_database.html> (accessed 9 July 2007).

[18] Data was taken from the 9 April 2007 satellite database prepared by the Union of Concerned Scientists. This spreadsheet is updated approximately every quarter from a variety of unclassified sources and is available at no charge at www.ucsusa.org/global_security/space_weapons/satellite_database.html. There is a wide discrepancy between different sources as to the numbers of satellites. For example, the Space Security Index of 2006, published by McGill University's Institute of Air and Space Law, only reported "more than 620 operational satellites" in 2006. "Space Security Index 2006" (2007) XXXII Ann. Air & Sp. L. 201, at 207 ["Space Security Index 2006"]. The Teal Group completed a survey in 2001, identifying between 600-610 satellites. "Teal Survey Counts 600-610 Active Satellites Currently in Orbit" (2 October 2001) online: SpaceRef.com <http://www.spaceref.com/news/viewpr.html?pid=6175> (accessed 6 July 2007). In contrast, a command spokesperson for USAF Space Command recently noted that there were roughly 700 active satellites that would, during part of their orbits, cross into Low Earth Orbit. "Chinese Missile Test Seen as US Threat" *Taranaki Daily News* (13 April 2007) 10. Given the widely conflicting estimates on active satellites, any compilation of numbers and statistics in this regard has been difficult. For the sake of consistency throughout this thesis, I have used the database maintained by the Union of Concerned Scientists, a free and seemingly comprehensive database on an easily searchable Excel spreadsheet.

[19] Pursuant to Article IV of the Convention on the Registration of Objects Launched into Outer Space, 14 January 1975, 1023 U.N.T.S. 15, 28 U.S.T. 695 [*Registration Convention*], each State that launches a space object into Earth orbit or beyond must "as soon as practicable" furnish basic information about that space object to the United Nations, including the name of the satellite, the date and location of the launch, and the "general function of the space object."

[20] "The term 'space object' includes component parts of a space object as well as its launch vehicle and parts thereof." *Ibid.*, art. I(c).

[21] "Convention on Registration of Objects Launched into Outer Space," online: United Nations <http://www.unoosa.org/oosa/en/SORegister/regist.html> (accessed 9 July 2007).

active satellites, twelve have neither ratified nor signed the *Registration Convention.*[22] Second, military satellites may be "classified" by their governments, and though astronomers may notice them, they may never be registered.[23] Finally, the number of "active" satellites is always changing—new satellites are being launched and older satellites either fall back to the Earth or just run out of fuel and become useless. All of these considerations help explain the wide discrepancy in reported "active satellites."

Satellites can be grouped broadly by function into six categories: (1) communications; (2) navigation; (3) remote-sensing and surveillance; (4) weather; (5) research satellites (both earth science and astronomy); and (6) manned space missions. The percentage of satellites engaged in the various uses is as follows:[24]

Communications Satellites	63%
Remote-Sensing / Surveillance	14%
Navigation Satellites	7%
Weather Satellites	5%
Other Scientific Satellites	11%

Satellites orbit the Earth at various altitudes and angles, their orbits largely dependent on their intended purpose. The most commonly used orbits and some of the most prominent satellite uses for each orbit are as follows:

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[22] Algeria, Brazil, Egypt, Luxembourg, Malaysia, Morocco, Nigeria, Philippines, Portugal, Saudi Arabia, South Africa and Thailand. "Status of International Agreements Relating to Activities in Outer Space," online: United Nations Office for Outer Space Affairs <http://www.unoosa.org/oosa/en/SpaceLaw/treatystatus/index.html> (accessed 9 July 2007).

[23] States that are Parties to the *Registration Convention* only need to provide information regarding their satellites for the United Nations Registry "as soon as practicable". *Registration Convention, supra* note 19, art. IV(1). It may not be "practicable" for a State to share this information for a classified military satellite.

[24] UCS Satellite Database, *supra* note 17.

Orbit	Altitude	Prominent Satellite Uses
Low Earth Orbit	~ 60 to 300 miles	Remote-Sensing, Manned Space Stations, Communications, Weather
Medium Earth Orbit	~ 300 to 22,300 miles	Navigation
Geostationary Earth Orbit	22,300 miles	Communications, Early Warning for Missile Launch
Highly Elliptical Orbit	Higher than 22,300 miles	Research, Astrophysics

This is, of course, highly simplified. There are communications satellites in all of the above orbits, just as there are surveillance satellites in Medium Earth Orbit and Geostationary Earth Orbit and weather satellites in Geostationary Earth Orbit. The chart is merely intended to give a general understanding of where satellites are commonly located. It only makes sense, that if a State wants a close look at the Earth, say for surveillance or weather monitoring, it would place its satellites in Low Earth Orbit. Likewise, for a broader view of the Earth, say, for increased line-of-sight for communications, a satellite in Geostationary Earth Orbit would be more suitable.

A. Communications Satellites

About 63 percent of all operational satellites are communications satellites (536 of 847).[25] Satellites are naturally suited for long-distance communications. They are, essentially, very tall relay stations for receiving and re-transmitting radio signals.[26] They are arguably superior to relay stations located on Earth in terms of both capability and cost. For example, it only takes three satellites, properly spaced in the Geostationary

[25] UCS Satellite Database, *supra* note 17. The Satellite Database maintained by Analytical Graphics, Inc. also listed 536 active communications satellites in 2006. *The Space Report: The Guide to Global Space Activity* (Colorado Springs: Space Foundation, 2006) at 37 [*Space Report*].

[26] Nicolas Mateesco Matte, ed., *Space Activities and Emerging International Law* (Montreal: McGill University, 1984) at 22.

Earth Orbit,[27] at 22,300 miles (35,780 kilometers) above the equator to broadcast a signal over the entire Earth.[28] Each satellite in Geostationary Earth Orbit has a continuous and unobstructed view of approximately 40 percent of the surface of the Earth. No tower built on the Earth can compete with that unobstructed view. In fact, "[o]ne repeater on a [Geostationary Earth Orbit] satellite can effectively do the work of thousands of repeaters on the ground."[29]

Additionally, satellites are capable of providing communications in spite of oceans or mountains—especially useful for ships and planes.[30] Using satellites for communications can permit a State to avoid building a tremendous amount of infrastructure. In many regions of the world, satellites could provide communications to rural areas that currently have limited communication capabilities. In fact, satellite communications are the only way possible to provide an instant connection for "approximately three-quarters of the Earth's surface (oceans, deserts, rain forests, mountain ranges, swamps, and bogs)".[31]

Communications satellites include satellites providing telephone services, data transmission, broadband Internet, and television and radio broadcasting. Communications satellites broadcast over 10,000 television channels to audiences 10 to

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[27] "[T]he geostationary orbit is the orbit, a satellite placed in which revolves around the Earth with the same speed as of the rotation of the Earth and thus appears to remain stationary over a given point on the surface of the Earth." Ram S. Jakhu, "The Legal Status of the Geostationary Orbit" (1982) 7 Ann. Air & Sp. L. 333, at 333, n. 1.

[28] Edward Ashford, "Communications" in Feuerbacher & Stoewer, *supra* note 12, 227 at 229.

[29] *Ibid.*

[30] Matte, *supra* note 26 at 22.

[31] Joseph N. Pelton, "Overview of Satellite Communications" in Takashi Iida, Joseph N. Pelton, & Edward Ashford, eds., *Satellite Communications in the 21st Century: Trends and Technologies* (Reston, VA: AIAA, 2003) 1 at 2.

100 times larger than those reached in pre-satellite days.[32] By 2009, annual revenues are expected to reach $80 billion for direct-to-home (satellite) television alone.[33] Communication satellites comprise the largest portion of the satellite industry's $180 billion in revenues in 2005.[34]

Militaries are increasingly dependent on space communications capabilities. During Operation DESERT STORM, fully 90 percent of all U.S. military communications traffic was borne by satellite.[35] Prominent U.S. military communications satellite systems include the Defense Satellite Communications System III, the Global Broadcast System, the Milstar Satellite Communications System, Polar Military Satellite Communications, and the UHF Follow-On Satellite system.[36] Future satellite systems include the Advanced Extremely High Frequency Satellite Communications System (AEHF),[37] the Enhanced Polar System, the Mobile User Objective System,[38] the Transformational Satellite Communications System (TSAT)[39]

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[32] *Ibid.*

[33] *Ibid.* at 69.

[34] Space Report, *supra* note 25 at 114.

[35] Dale R. Hamon and Walter G. Green III, "Space and Power Projection" (November 1994) 11 Military Review 64 at 74.

[36] Mehuron, "Space Almanac", *supra* note 13 at 81-83.

[37] A USAF constellation of communications satellites that will provide anti-jam and secure extremely high frequency communications (EHF) to the warfighter. The first launch is expected in 2008. U.S., Department of Defense, *Program Acquisition Costs by Weapon System: Department of Defense Budget for FY 2008*, (February 2007) at 62, online: U.S. Department of Defense Publications <http://www.defenselink.mil/pubs/> (accessed 2 July 2007) [U.S., *Costs by Weapon System*].

[38] A U.S. Navy satellite program, consisting of a constellation of satellites providing advanced UHF narrow-band communications in support of deployed troops. The first such satellite is scheduled for launch in 2010. *Ibid.* at 61.

[39] TSAT is the intended replacement for the AEHF satellite constellation—which is itself a future system. TSAT will provide "secure, survivable, anti-jam communications for strategic and tactical users" by "using

and the Wideband Gap-filler System.[40] The United States military also uses numerous civilian satellites for communications.[41]

B. Reconnaissance / Remote-Sensing Satellites

Remote-sensing is "the sensing of the Earth's surface from space by making use of the properties of electromagnetic waves emitted, reflected or diffracted by the sensed objects, for the purpose of improving natural resources management, land use and the protection of the environment."[42] "[R]emote sensing has been used to gather information needed in the fields of agriculture, geography, geology, hydrology, oceanography, meteorology, pollution, natural disasters and other civilian endeavors, it also has been increasingly used for military reconnaissance and verification of arms control agreements ...."[43] Remote-sensing has also been used for mapping, search and rescue operations and forest fire recognition.[44]

There are approximately 116 active remote-sensing satellites of various types, orbits and functions[45] in space.[46] There is a large legal advantage to taking pictures from

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internet protocol packet switching and laser technologies." First launch is expected in FY 2014. *Ibid.* at 69.

[40] A five-satellite communications constellation to be launched in FY 2007. *Ibid.* at 70.

[41] E.g., Iridium, Orbcomm, Pan Am Sat, Inmarsat, Globalstar, Intelsat and Telstar. Mehuron, "Space Almanac", *supra* note 13 at 83-84.

[42] *Principles Relating to Remote Sensing of the Earth from Outer Space*, GA Res. 41/65, UN GAOR, 41st Sess., UN Doc. A/RES/41/65 (1986) principle I(a).

[43] Stephen Gorove, "The U.N. Principles on Remote Sensing: Focus on Possible Controversial Issues" in Guido Rinaldi Baccelli, ed., *Liber Amicorum Honouring Nicholas Mateesco Matte: Beyond Boundaries* (Montreal: De Daro Publishing, 1989) 105, at 106.

[44] UCS Satellite Database, *supra* note 17.

[45] I broadly group as "remote-sensing" satellites variously categorized by the Union of Concerned Scientists as early warning satellites (9); various Earth observation satellites (25); Earth science (2); electronic intelligence satellites (6); various satellites cataloged merely as "remote-sensing" satellites (31); and, reconnaissance and surveillance satellites (43).

space (rather than from airplanes). Specifically, while States are sovereign over their airspace,[47] outer space is completely free of all claims of sovereignty.[48] Thus, though flying a plane without permission over another State's territory to take pictures would invoke protest (at the least) and likely invoke a military response,[49] taking pictures from a satellite has not involved even the slightest protests.

Current U.S. military satellites providing surveillance of various kinds include the Defense Support Program (provides early warning of missile launches)[50] and various classified systems "such as White Cloud (ocean reconnaissance), Aquacade (electronic ferret), and Trumpet (Sigint), [that] are essentially open secrets but cannot be confirmed by the Intelligence Community."[51] Future planned satellite systems include Space Based Infrared System High (an advanced, steerable, missile warning surveillance system),[52]

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[46] UCS Satellite Database, *supra* note 17.

[47] "[E]very State has complete and exclusive sovereignty over the airspace above its territory." *Convention on International Civil Aviation*, Dec. 7, 1944, 15 U.N.T.S. 295, art. 1.

[48] "Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies." *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, 27 January 1967, 610 U.N.T.S. 205, 18 U.S.T. 2410 [*Outer Space Treaty*].

[49] In 1956 the U.S. began flights over the USSR in a high-altitude reconnaissance aircraft called the U-2. In May of 1960, the USSR shot a U-2 flown by Gary Powers out of its airspace, ending U.S. aerial overflights over the USSR. Paul B. Stares, *The Militarization of Space: U.S. Policy, 1945-1984* (New York: Cornell University Press, 1985) at 32 & 46. Powers successfully parachuted to safety, was captured, tried, convicted, and imprisoned until his release two years later in exchange for a Soviet spy. Bin Cheng, *Studies in International Space Law* (Oxford: Clarendon Press, 1997) at 104, n.78.

[50] Mehuron, "Space Almanac", *supra* note 13 at 81-82.

[51] *Ibid.* at 83.

[52] A four-satellite constellation, consisting of two satellites in the Geostationary Orbit and two satellites in a highly elliptical orbit that will provide initial warning to the U.S. of ballistic missile attacks, provides battlespace awareness and conducts technical intelligence missions. This system is scheduled to begin operation in FY 2009. U.S., *Costs by Weapon System*, *supra* note 37 at 67. See also Major General Frank Faykes, Director, Air Force Budget, "FY08 President's Budget" (5 February 2007) slide 41, online: Secretary of the Air Force: Financial Management & Comptroller <http://www.saffm.hq.af.mil/shared/media/document/AFD-070212-012.pdf> (accessed 30 May 2007). See

Space Radar (all weather, day and night tracking of moving or fixed ground targets in all terrains, including within urban areas),[53] and the Space Tracking and Surveillance System (used to detect and track ballistic missiles).[54] U.S. governmental satellites can provide images with a resolution between .10 meters (the size of a baseball) and .15 meters (meaning that objects measuring .10 to .15 meters and larger will show up in their photos).[55]

U.S. military reconnaissance satellites enable the real-time tracking of troops, vehicles, aircraft and even submarines, which, when combined with other space assets, "give commanders a continuous picture of their forces' location and movements ...."[56]

Reconnaissance images are available at no cost to anyone with an Internet connection via Google Earth.[57] Google Earth, an interactive map of the Earth, is constructed entirely of satellite images and provides free imagery to anyone with an Internet connection.[58] Satellite photographs retrieved for free on Google Earth can be used in the planning of military attacks. Recently, photograph printouts taken from the Google Earth website were seized from homes of insurgents in Iraq. The photographs

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U.S., United States Air Force, *The U.S. Air Force Transformational Flight Plan* (November 2003) at B-6 [U.S., *Transformational Flight Plan*].

[53] The first launch of this system is not planned until FY 2016. U.S., *Costs by Weapon System*, *supra* note 37 at 68. See also U.S., *Transformational Flight Plan*, *supra* note 52 at B-6 and B-20.

[54] Mehuron, "Space Almanac", *supra* note 13 at 82.

[55] Ram Jakhu, "International Law Governing the Acquisition and Dissemination of Satellite Imagery" (2003) 29 J. Space L. 65 at 66 & 71.

[56] William B. Scott, "Improved Milspace Key to Antiterrorism War; Investments in 'blue force tracking' and real time air strike monitoring systems pay dividends in Afghanistan" *AW&ST* 155:24 (10 December 2001) 36.

[57] Google Earth, Online: Google Earth <http://earth.google.com> (accessed 11 June 2007).

[58] *Space Report*, *supra* note 25 at 85.

showed detailed pictures of British bases, including their tents, restrooms, and parking for their military vehicles.[59] On the back of the retrieved pictures, insurgents had written the precise longitude and latitude coordinates for potential targets.[60] Several nations (the U.K., India, South Korea and the Netherlands) have complained about the potential use by terrorists of the information freely available on Google Earth.[61]

Civil and commercial remote-sensing satellites can provide images with a resolution finer than 39 meters.[62] The highest resolution image currently available from a commercial satellite is .6 meters.[63] In 2005, the commercial remote-sensing industry had revenues of about $1.12 billion.[64] The expense of manufacturing and launching these satellites is where corporations make their money—it has been estimated that between 2004 and 2013 approximately 170 remote-sensing satellites will be manufactured—costing an estimated $15.5 billion.[65] Governments remain the main clientele for the majority of the images sold by commercial remote-sensing satellites.[66]

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[59] Lester Haines, "Google erases British bases in Iraq" *The Register* (17 January 2007), online: The Register <http://www.theregister.co.uk/2007/01/17/google_erases_brit_bases> (accessed 9 July 2007).

[60] *Ibid.*

[61] Dinesh C. Sharma, "Indian president warns against Google Earth" *CNET News.com* (17 October 2005), online: CNET News.com <http://news.com.com/Indian+president+warns+against+Google+Earth/2100-1028_3-5896888.html> (accessed 11 June 2007).

[62] *Space Report*, *supra* note 25 at 7.

[63] Digital Globe, a U.S. company, owns Quickbird 2, which is capable of taking images with a resolution of .6 meters—you can see objects measuring a mere 2 feet across. "Digital Globe Fact Sheet", online: Digital Globe <http://www.digitalglobe.com/about/factsheet.shtml> (accessed 19 June 2007).

[64] *Space Report*, *supra* note 25 at 71.

[65] *Ibid.*

[66] *Ibid.* at 57.

C. Navigation Satellites

Navigation satellites report to users their exact position to within 5 to 10 meters, day or night and in all weather conditions.[67] They are even more accurate for stationary objects—providing positions to within a few centimeters.[68] All a user needs in order to use these satellites is a simple receiver to pick up the signals transmitted by the navigational satellites. Such receivers are now common in airplanes, boats, cars, cell phones and even watches.[69] "Satellite navigation delivers positioning and time, independent of weather, around the globe and in space near the earth, 24 hours a day. It is thereby more efficient in terms of accuracy, availability, integrity and continuity than any other terrestrial sensor or method."[70]

There are currently 62 active navigational satellites.[71] These systems, collectively known as Global Navigation Satellite Systems (GNSS), are made up of the United States Global Positioning System (GPS),[72] Russia's Global Navigation Satellite System (GLONASS),[73] China's Beidou navigation satellites,[74] and one satellite belonging to the

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[67] "ESA Navigation" online: European Space Agency <http://www.esa.int/esaNA/GGGYC650NDC_index_0.html> (accessed 9 July 2007).

[68] *Ibid.*

[69] *Ibid.*

[70] Günter W. Hein, "Satellite Navigation" in Feuerbacher & Stoewer, *supra* note 12, 251 at 251.

[71] UCS Satellite Database, *supra* note 17.

[72] GPS is the U.S. space-based radio-navigation system consisting of 24 satellites orbiting 12,600 miles above the Earth. It provides positioning, navigation and timing services to the U.S. military, and is also freely-available to civilians around the world. "Global Positioning System: Serving the World" online: Global Positioning System <http://www.gps.gov>.

[73] GLONASS is Russia's constellation of 24 navigation satellites (3 of them are spares) orbiting the Earth at an altitude of 19,100 km. GLONASS is not operating at full capacity. Only 17-18 of the satellites are currently in orbit and four of them are reportedly switched off. See Russian Space Agency, online: Russian Space Agency <http://www.glonass-ianc.rsa.ru/pls/htmldb/f?p=202:20:6005261717971075290::NO> (accessed 9 July 2007). See also UCS Satellite Database, *supra* note 17.

European Space Agency (the first satellite of Europe's planned Galileo navigation system).[75]

GPS provides the U.S. military "a global, three-dimensional positioning, velocity and time information system for aircraft, artillery, ships, tanks and other weapons delivery systems."[76] This navigation capability functions day and night and in any weather.

GPS is also used by the United States military for precision targeting. One B-2 "Spirit" bomber deploying 16 GPS precision-guided Joint-Direct Attack Munitions (JDAMs), has the same destructive capacity of 1,500 B-17 sorties carrying 1,125 tons of non-precision-guided ("dumb") bombs in World War II.[77] Using precision targeting, in October of 2003, one B-2 bomber successfully targeted 80 separate targets using 80 JDAMs in a single 22-second pass.[78] The all-weather ability provided by GPS-guided munitions provides a distinct advantage over other precision-guided munitions (i.e., laser and electro-optical-guided munitions) as these other munitions are far less accurate when

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[74] The Beidou Navigation System consists of two satellites in the Geostationary orbit. Shu-Hsien Liao, "Will China become a military space superpower?" (August 2005) 21:3 Space Pol'y 205 at 209.

[75] The European Union has been planning its own global navigation system of 30 satellites to rival the U.S.'s GPS satellites. The navigation system has encountered serious financial troubles and will likely only be completed in 2010 or 2011 if the EU increases public funding for the project. The current plan for funding provides that two-thirds of the construction and launch costs of the 30 satellites would come from a consortium of eight private companies. "EU sees public money saving Galileo from drifting off course" *GPS Daily* (11 May 2007), online: GPS Daily <http://www.gpsdaily.com/reports/EU_Sees_Public_Money_Saving_Galileo_From_Drifting_Off_Course_999.html> (accessed 6 July 2007).

[76] U.S., *Costs by Weapon System, supra* note 37 at 65.

[77] Brian E. Fredriksson, "Globalness: Toward a Space Power Theory" (Maxwell AFB, AL: Air University Press, 2006) at 18.

[78] "Joint Direct Attack Munitions (JDAM)," online: Defense Update: International Online Defense Magazine <http://www.defense-update.com/products/j/jdam.htm> (accessed 7 June 2007).

visibility is poor (e.g., due to cloud cover or sandstorms).[79] As Air Force General Kevin P. Chilton, Commander of Air Force Space Command, recently testified before the House Armed Services Committee, "GPS is integral to numerous battlefield innovations, including the Small Diameter Bomb, the Guided Multiple Launch Rocket System and Joint Precision Air Drop System. We have also delivered almost 100,000 advanced GPS receivers to the field."[80] The combination of precision targeting and pinpoint navigation (even across trackless deserts) has made GPS indispensable to the U.S. military.

Global navigation satellite systems (GNSS) have been widely used by the civil aviation community for the increased capabilities it provides for navigating aircraft. Using GNSS, aircraft can be guided on more precise routes, burning less fuel and saving time. Using GNSS, less time is needed between landing each aircraft, increasing the volume of traffic an airport can safely handle (and further saving on fuel costs). The former President of the Council of the International Civil Aviation Organization (ICAO), Assad Kotaite, described global navigation satellite systems as "an electronic aid which may be used to determine in the course of aircraft flight the real-time position of the aircraft, its course and distance to the desired destination, and any deviation from the desired track."[81]

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[79] U.S., United States Air Force, *Space Operations*, Air Force Doctrine Document 2-2 (27 November 2006) at 33 [U.S., *Space Operations*].

[80] U.S., *FY 2008 National Defense Authorization Budget Request and the Status of Space Activities: Hearing Before the Strategic Forces Subcommittee of the House Armed Services Committee,* 110th Cong. (23 March 2007) at 11 (General Kevin P. Chilton, Commander, Air Force Space Command), online: House Armed Services Committee <http://armedservices.house.gov/hearing_information.shtml> [U.S., Chilton Testimony] (accessed 10 June 2007).

[81] Assad Kotaite, "ICAO's Role With Respect to the Institutional Arrangements and Legal Framework of Global Navigation Satellite System (GNSS) Planning and Implementation" (1996) XXI-II Ann. Air & Sp. L. 195 at 196.

In addition to their value to the military and aviation communities, navigation satellites are widely used in a wide range of other civil applications, including: maritime navigation; roads and highways; space applications; agriculture; train transportation; environmental applications; surveying and mapping; and, recreational use.[82] In 2005, revenues for GNSS applications were $22 billion.[83]

D. Weather Satellites

Weather satellites ("meteorological" satellites) are widely used for monitoring clouds, winds, temperature and humidity, precipitation, waves, aerosols and trace gases, and forest fires.[84] They allow increasingly accurate weather prediction, including severe weather forecasting of tornadoes, winter storms and hurricanes.[85] Weather reports are not merely convenient for planning travel and recreational activities, but also for planning military operations. Sun Tzu, a Chinese military strategist from the 6th Century B.C., considered the importance of weather when writing his famous book, *The Art of War*. He wrote of the weather as "Heaven" and noted "[i]f you know Heaven [the weather] and know Earth [the terrain], your victory can be complete."[86] In March of 2003, amid rain and low visibility, over 1,000 U.S. soldiers waited aboard 17 C-17 Globemaster IIIs for the right weather to be able to parachute into northern Iraq. In spite of mission-preventing weather, the weather officer, consulting data obtained from weather satellites, assured commanders the weather would clear up long enough for the mission to

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[82] "Global Positioning System: Serving the World" online: Global Positioning System <http://www.gps.gov> (accessed 10 July 2007).

[83] *Space Report*, *supra* note 25 at 72.

[84] UCS Satellite Database, *supra* note 17.

[85] *Ibid.*

[86] Sun Tzu, *The Art of War* (New York: Barnes & Noble Books, 1994) at 215.

proceed—as predicted, the clouds parted and the jump was able to continue as planned.[87] Weather satellites are critical not only for deciding when to stage an attack, but what munitions to use (laser-, infrared and optical-guided munitions require relatively clear weather).[88]

The U.S. military currently operates a couple of military weather satellites, known together as the Defense Meteorological Satellite Program.[89] The U.S. military also makes use of civilian systems for its meteorological requirements.[90] The U.S. Air Force (USAF) is building a 4-satellite constellation known as the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) to monitor world-wide environmental conditions, covering land, ocean and near-space.[91] This system is expected begin operations in Fiscal Year (FY) 2013 (between 1 October 2012 and 30 September 2013).[92]

Calculating the total number of active meteorological satellites is somewhat difficult. There are about 39 weather satellites listed on the UCS Database, and many more that could have been grouped as weather satellites, but were instead grouped as "research" or "remote-sensing" satellites.[93]

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[87] J. G. Buzanowski, "Space superiority a priority for Air Force authority" *Air Force Print News* (12 April 2006) online: Air Force Link <http://www.af.mil/news/story.asp?storyID=123018955> (accessed 31 May 2007).

[88] Chun, *Defending Space*, *supra* note 11 at 44.

[89] Mehuron, "Space Almanac", *supra* note 13 at 81.

[90] *Ibid.* at 83-84.

[91] U.S., *Costs by Weapon System*, *supra* note 37 at 66.

[92] *Ibid.* at 62.

[93] UCS Satellite Database, *supra* note 17.

E. Research Satellites

Research satellites make up around 11 percent of the total 847 satellites.[94] Satellites study numerous aspects of both the Earth and space. Topics under study include: Earth's gravity fields; Earth's environment; Earth's aurora; Earth's magnetotail; sea-level changes; wave heights; oceanography and charting of ocean resources; land and agricultural surveys; fundamental aspects of the universe; solar irradiance; gamma-ray sky; and, solar winds.[95]

F. Manned Space Missions

The database created by the Union of Concerned Scientists[96] completely omitted manned satellites (perhaps because of their temporary nature—for example, do you count each of the U.S. Space Shuttles every time they complete a mission or only once?). For the sake of statistics, and following the example of the Union of Concerned Scientists, I have kept manned space missions out of all statistical calculations.

Of the eight States that have the technical means to launch an object into space, only the U.S., Russia, and recently, China[97] have the ability to launch a human being into space. Apollo 11's trip to the Moon in 1969 was certainly the most famous of the manned space missions. Apollo 11 was not the first manned space mission, however. There had been 18 manned missions from 1961 through 1968 and another 3 manned

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[94] *Ibid.*

[95] *Ibid.*

[96] *Ibid.*

[97] On 15 October 2003, China became the third country to launch an astronaut into orbit. Brian Harvey, *China's Space Program: From Conception to Manned Spaceflight* (London: Springer, 2004) at xi.

space missions in 1969 besides Apollo 11.[98] Between 1961 and 2005 there were a total of 144 manned spaceflights, carrying 743 people into space.[99]

Despite these forays into space, mankind has only skimmed the surface of exploration. Consider that the farthest a manned spaceflight has ventured into space was to the moon—238,855 miles (384,400 km).[100] For a little perspective, our Sun is 92.96 million miles[101] away from the Earth and is only one of about 200 billion stars that make up our galaxy (the Milky Way)[102]—and the Milky Way is only one of billions of known galaxies.[103] All of these stars and galaxies are tremendous distances from each other—for example, the nearest star to our Sun is Proxima Centauri—which is about 24,634,400,000,000 miles from the Sun.[104]

The U.S. Space Shuttle completed 114 missions in the 25 years preceding 2005. It helped in the construction and logistical support of the International Space Station, conducted scientific missions, missions for the Department of Defense, satellite

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[98] Mehuron, "Space Almanac", *supra* note 13 at 79.

[99] *Ibid.* Some of these people have ventured into space more than once. For the numbers of actual human beings who have made it to space (one or more times), it is probably more accurate just to say "over 400." National Aeronautics and Space Administration, "Space Station" online: NASA <http://www.nasa.gov/mission_pages/station/main/index.html> (accessed 18 May 2007).

[100] National Aeronautics and Space Administration, "Solar System Exploration" online: NASA <http://sse.jpl.nasa.gov/planets/profile.cfm?Object=Moon> (accessed 8 June 2007).

[101] The distance from the Earth to the Sun is commonly referred to as one Astronomical Unit (AU) to avoid the incredibly large numbers that would result if distances were measured miles or kilometers. National Aeronautics and Space Administration, "Basics of Space Flight" online: Jet Propulsion Laboratory <http://www2.jpl.nasa.gov/basics/bsfl-1.html> (accessed 8 June 2007).

[102] *Ibid.*

[103] *Ibid.*

[104] Once scientists begin measuring distances of this magnitude, they usually use the "light year" or the distance that a beam of light can travel in a year. Light travels at about 300,000 km per second. Proxima Centauri is about 4.2 light years from our Sun. *Ibid.*

deployments, repairs and retrievals and cooperative missions to the Russian Mir Space Station.[105]

Russia's Mir space station was originally designed for military uses, but was later used for scientific investigations.[106] The Mir space station orbited the Earth at a height of 300-400 km above the Earth.[107] It provided Russia a continuous presence in space for 15 years (from 1986 until 2001), and was visited by over 100 astronauts.[108]

Today's most famous manned space station is the International Space Station, a combined international effort of sixteen States.[109] The International Space Station, probably the largest engineering feat ever attempted by mankind,[110] was conceived for the vague purpose of "enhancing the scientific, technological, and commercial use of outer space."[111]

The International Space Station is not registered in the U.N. registry of space objects as a single space station; rather, each and every module sent to the International

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[105] Roger D. Launius, "Accessing the Legacy of the Space Shuttle" (November 2006) 22:4 Space Pol'y 226 at 230.

[106] Feuerbacher, *supra* note 12 at 16.

[107] Lorenz Ratke, "Materials Sciences" in Feuerbacher & Stoewer, *supra* note 12, 297 at 342.

[108] *Ibid.*

[109] The 15 States cooperating on the International Space Station include the U.S., Russia, Japan, Canada and the eleven States that are members of the European Space Agency (Belgium, Denmark, France, Germany, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom). *Agreement among the government of Canada, governments of Member States of the European Space Agency, the government of Japan, the government of the Russian Federation, and the government of the United States of America concerning cooperation on the Civil International Space Station*, Jan. 29, 1998, Hein's No. KAV 5119, reprinted in *United States Space Law: National & International Regulation*, Vol. 4 (New York: Oceana Publications, 1980), II.A. 22(f) (May 1998) [*1998 IGA*].

[110] NASA considers the construction of the International Space Station as likely more difficult than their earlier mission to land on the moon. U.S., National Aeronautics and Space Administration, *FY 2008 Budget Estimates*, (2007) at 2, online: NASA < http://www.nasa.gov/about/budget/index.html> [U.S., *NASA Budget*] (accessed 2 July 2007).

[111] *1998 IGA*, *supra* note 109, art. 1(1).

Space Station is required to be registered by the State that sent it.[112] It was designed for a crew of between six or seven to live and work in a Low Earth Orbit of around 400 km.[113] It has been scaled down to a crew of three[114] and is currently orbiting the Earth at around 350 km.[115] The first portion of the International Space Station to reach orbit was a Russian cargo bay in November of 1998.[116] Though completion was originally planned for the end of 2004,[117] the International Space Station is still far from completion.[118] The original anticipated cost of the project was between $60-100 billion.[119] George Washington University's Space & Advanced Communications Research Institute also recently estimated the total cost of the International Space Station at $100 billion.[120] The

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[112] "In accordance with Article II of the Registration Convention, each Partner shall register as space objects the flight elements ... which it provides ...." *1998 IGA*, *supra* note 109, art. 5(1).

[113] Alexander V. Yakovenko, "The intergovernmental agreement on the International Space Station" (May 1999) 15:2 Space Pol'y 79 at 84.

[114] U.S., National Aeronautics and Space Administration, *International Space Station Guide*, (16 January 2007) at Introduction, online: NASA, <http://www.nasa.gov/mission_pages/station/news/ISS_Reference_Guide.html> [U.S., *Space Station Guide*] (accessed 10 July 2007).

[115] U.S., National Aeronautics and Space Administration, *International Space Station Status Report: S S07-26* (15 May 2007) online: NASA, <http://www.nasa.gov/home/hqnews/2007/may/HQ_SS0726_station_status.html> (accessed 6 July 2007).

[116] Yakovenko, *supra* note 113 at 84.

[117] Rochus Moenter, "The International Space Station: Legal Framework and Current Status" (1999) 64 J. Air L. & Com. 1033 at 1036.

[118] NASA currently predicts the International Space Station will be fully assembled in 2010. U.S., *Space Station Guide*, *supra* note 114 at Introduction.

[119] Moenter, *supra* note 117 at 1036.

[120] "Executive Report: Space Safety Report: Vulnerabilities and Risk Reduction in U.S. Human Space Flight Programs" (March 2005) at VII, online: Astronaut Space Safety <http://www.spacesafety.org/spacesafety05.html> (accessed 4 June 2007).

U.S. spent at least $6.8 billion on the International Space Station in 2006 alone and the anticipated budget from 2007 through 2010 is another $26 billion.[121]

Space stations, including the International Space Station, have been widely used for research. Studies include research on weightlessness, microgravity, telemedicine, earth observations (its range covers over 90 percent of the populated areas of Earth[122]), protein crystal growth experiments, and, of course, one large experiment on living in space, a precursor to any long manned space flight.[123]

A final manned space activity that is currently vogue among the extremely wealthy is space tourism. From April 2001 to April 2007, five people (four from the U.S. and one from South Africa) bought rides to the International Space Station aboard the Russian Soyuz rocket at a cost of over $20 million per ride.[124] Cheaper travel to space is currently being developed by a couple of private companies. Both Virgin Galactic and the European Aeronautic Defence and Space Company have plans to take tourists into Low Earth Orbit for about $200,000 a seat by 2010. Their customers would have the chance to experience weightlessness for about six minutes and have the opportunity to see the curvature of the Earth from in space.[125]

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[121] The U.S. spent $1.7 billion for the International Space Station, another $4.8 billion for the Space Shuttle (largely transportation and logistical support to and from the International Space Station) and another $338 million for space and flight support for the program. The budget request is anticipated to be slightly more for the next four years. U.S., *NASA Budget*, *supra* note 110 at 9.

[122] U.S., *Space Station Guide*, *supra* note 114 at 90.

[123] National Aeronautics and Space Administration, "ISS Research" online: <http://exploration.nasa.gov/programs/station/index.html> (accessed 18 May 2007).

[124] Voice of America, "Fifth 'Space Tourist' Begins Flight to International Space Station" *US Fed News Service* (8 April 2007), online: Voice of America <http://www.voanews.com/english/archive/2007-04/2007-04-08-voa4.cfm?CFID=151305024&CFTOKEN=14613249> (accessed 18 May 2007).

[125] "Eads is aiming to beat Branson as tourism joins the space race" *Evening Standard* (12 June 2007) 28.

Future planned forays into space include U.S. plans to send a manned spaceflight back to the Moon and then on to Mars.[126] China has the goal of having a manned space station by 2020[127] and perhaps also sending a man to the Moon by the same year.[128] Russia is also contemplating manned missions to Mars between 2020 and 2030.[129]

Having addressed the wide variety of satellites (current and future), and their diverse applications—both military and civilian—I turn to the variety of weapons that have been created to destroy or disable these satellites—ASATs.

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[126] The U.S.'s *2006 National Space Policy* speaks of the U.S. "objective of extending the human presence across the solar system". U.S., *U.S. National Space Policy,* National Security Presidential Directive-49 (31 August 2006) at 2 [U.S., *2006 National Space Policy*]. President Bush also listed in his "Vision for U.S. Space Exploration" the goal to "[e]xtend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations." U.S., National Aeronautics and Space Administration, *The Vision for Space Exploration* (February 2004) online: NASA <http://www.nasa.gov/mission_pages/exploration/main/index.html> (accessed 8 June 2007).

[127] U.S., Department of Defense, *Annual Report to Congress: Military Power of the People's Republic of China* (2007) at 20, online: U.S. Department of Defense Publications <http://www.defenselink.mil/pubs/china.html> [U.S., *2007 Report on China's Military Power*] (accessed 5 July 2007).

[128] "China's Moon Flights" online: Space Today Online <http://www.spacetoday.org/China/ChinaMoonflight.html> (accessed 8 June 2007). China's recent space policy however, did not mention the return to the Moon as one of the goals of its space program. White Paper issued by the Information Office of China's State Council (October 2006), online: Peoples Daily Online website http://english.people.com.cn/200610/12/eng20061012_311149.html [China, White Paper] (accessed 8 June 2007).

[129] Yury Zaitsev, "Russian Space Goals in the Early 21st Century" *Space Daily* (2 January 2007), online: Space Daily <http://www.spacedaily.com/reports/Russian_Space_Goals_In_The_Early_21st_Century_999.html>. (accessed 8 June 2007).

Chapter Two: Anti-Satellite Weapons

A. Past, Present & Future ASATs

ASATs are defined by the USAF as "direct ascent and co-orbital systems that employ various mechanisms to affect or destroy an on-orbit spacecraft."[130] They can be broken into several categories: High altitude nuclear explosions, kinetic-energy ASATs, laser ASATs, various electronic "jamming" measures, and ballistic missile defense systems.

1. High Altitude Nuclear Explosions

In 1958, to study the effects of a nuclear explosion in space and to see if such an explosion could destroy a satellite, the U.S. launched three X-17A missiles armed with nuclear warheads off a ship (the USS Norton Sound) in a series of three tests called Project Argus.[131] The results of the project confirmed that nuclear explosions in space could be used to destroy satellites—specifically, the nuclear explosions "created free electrons that produced X-rays capable of damaging electronic components and erasing computer memories."[132]

Four years later, Project STARFISH Prime, was jointly conducted by the USAF and the U.S. Atomic Energy Commission. On 9 July 1962, the U.S. detonated a nuclear-tipped Thor intermediate-range ballistic missile 248 miles above Johnston Island in the Pacific. This missile was several hundred times stronger than those previously tested in

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[130] U.S., United States Air Force, *Counterspace Operations*, Air Force Doctrine Document 2-2.1 (2 August 2004) at 33 [U.S., *Counterspace Operations*].

[131] Chun, Clayton, K.S. *Shooting Down a "Star": Program 437, the US Nuclear ASAT System and Present-Day Copycat Killers* (Maxwell AFB, AL: Air University Press, 2000), at 3-4 [Chun, *Shooting Down a Star*].

[132] *Ibid.* at 3.

Project Argus.[133] The results were dramatic. Electrical systems in Hawaii (715 miles away) were knocked out[134] by the electromagnetic pulse (EMP) from the nuclear explosion.[135] The explosion also "seriously damaged the solar panels of three orbiting satellites even though they were not in the line-of-sight of the nuclear detonation."[136] Some have characterized Project STARFISH as a test of a high-altitude nuclear weapon that, only incidentally (or even "accidentally") destroyed a number of satellites orbiting nearby.[137]

After Project STARFISH, the U.S. developed ASAT programs for destroying satellites by detonating a nuclear device nearby. In the 1960's, the U.S. had two nuclear ASAT programs, both using surface to air missiles. First, was an Army program called Program 505, or "Nike-Zeus." Program 505, based at Kwajalein Atoll in the Pacific, could destroy a satellite in Low Earth Orbit by launching a Nike-Zeus surface to air missile to explode near the target satellite—creating a 400-kiloton[138] nuclear explosion.[139] Program 437 (code-named SQUANTO TERROR), like Project STARFISH, launched a Thor intermediate-range ballistic missile from Johnston Island to

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[133] Chun, *Shooting Down a Star*, *supra* note 131 at 3-4.

[134] Effects included "the failure of street lighting systems, tripping of circuit breakers, triggering of burglar alarms, and damage to a telecommunications relay facility." Independent Working Group, *Missile Defense, the Space Relationship, & the Twenty-First Century: 2007 Report* (Cambridge, MA: Institute for Foreign Policy Analysis, 2006) at 8-9, online: Institute for Foreign Policy Analysis <http://www.ifpa.org/publications/IWGReport.htm> [Independent Working Group] (accessed 10 July 2007).

[135] Chun, *Shooting Down a Star*, *supra* note 131 at 4.

[136] Ibid.

[137] Karas, *supra* note 1 at 148.

[138] 400,000 tons.

[139] Chun, *Defending Space*, *supra* note 11 at 32-33.

deliver a 1.44 megaton[140] nuclear explosion to destroy satellites.[141] Both programs had only limited capability as an ASAT for several reasons. First, they were both operated from fixed stations—hence they would have to wait for their target to orbit past them before they could fire on it.[142]

Second, the fact that both programs launched a nuclear-tipped warhead was also a limitation, as after the STARFISH tests, it was apparent that any nuclear explosion in space would likely damage any U.S. satellites in the vicinity of the target.[143] Furthermore, attacking a satellite with a nuclear-tipped ASAT may well trigger a nuclear war.[144] Though both programs went operational in May of 1964, Program 505 was discontinued two years later in deference to Program 437.[145] Besides the stronger nuclear explosion, Program 437's Thor missile had a range of 1,500 miles,[146] substantially greater than the Nike-Zeus's range of 250 miles.[147] Program 437's launchers remained ready to launch until 1975.[148] One strange fact about these ASAT programs is that they were in operation after President Kennedy had signed the *Limited*

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[140] 1,440,000 tons. "[T]he lethal range of even a 1-megaton explosion against a satellite hardened to feasible hardness is less than 100 km. (An unhardened civilian communication satellite could be damaged at distances of thousands of kilometers by a high-yield nuclear explosion in space.)" Michael M. May, "Safeguarding Our Military Space Systems" (18 April 1986) 232:4748 Science 336 at 337.

[141] Chun, *Defending Space*, *supra* note 11 at 33.

[142] Stares, *supra* note 49 at 81.

[143] *Ibid.*

[144] Chun, *Shooting Down a Star*, *supra* note 131 at 21.

[145] David W. Zeigler, "Safe Heavens: Military Strategy and Space Sanctuary" in Bruce M. DeBlois, ed., *Beyond the Paths of Heaven: The Emergence of Space Power Thought*, (Maxwell Air Force Base, AL: Air University Press, 1999) 185 at 196.

[146] Chun, *Shooting Down a Star*, *supra* note 130 at 71, n. 12.

[147] *Ibid.* at 8.

[148] Karas, *supra* note 1 at 149.

Nuclear Test Ban Treaty, in fact, President Kennedy approved Program 437 the day after he signed the treaty.[149] The *Limited Nuclear Test Ban Treaty* made it unlawful to detonate nuclear weapons in space (but it arguably only restricted "tests").[150]

Nuclear ASATs remain a threat to satellite systems. "To execute this mission, all that is needed is a rocket and a simple nuclear device."[151] Eight, or perhaps nine, countries currently possess nuclear weapons: the U.S., Russia, China, the U.K., France, India, Pakistan, Israel and possibly North Korea.[152] Iran also possesses missiles that could carry a warhead to the necessary altitude and is believed to be trying to develop nuclear weapons.[153] This is especially concerning considering the famous position of President Mahmoud Ahmadinejad of Iran, "Israel must be wiped out from the map of the

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[149] Zeigler, *supra* note 145 at 196.

[150] "Each of the Parties to this Treaty undertakes to prohibit, to prevent, and not to carry out any nuclear weapon test explosion, or any other nuclear explosion, at any place under its jurisdiction or control: (a) in the atmosphere; beyond its limits, including outer space ...." *Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water*, 5 August 1963, 480 U.N.T.S. 43, 14 U.S.T. 1313.

[151] U.S., *Report of the Commission to Access United States National Security Space Management and Organization: Pursuant to Public Law 106-65* (11 January 2001) 22 [U.S., *Space Commission Report*].

[152] "Space Security Index 2006", *supra* note 18 at 427. See Joseph Cirincione, "The Declining Ballistic Missile Threat, 2005" *Carnegie Endowment for International Peace* (February 2005), online: Carnegie Endowment for International Peace <http://www.carnegieendowment.org/files/DecliningBallisticMissileThreat2005-2.pdf> (accessed 29 May 2007).

[153] U.S., *Space Commission Report*, *supra* note 151 at 22. In 2006, the U.S. Congress made the following findings regarding North Korea and Iran when approving missile-defense capabilities: "According to assessments by the intelligence community of the United States, North Korea tested in 2005 a new solid propellant short-range ballistic missile, conducted a launch of a Taepodong-2 ballistic missile/space launch vehicle in 2006, and is likely developing intermediate-range and intercontinental ballistic missile capabilities that could someday reach as far as the United States with a nuclear payload." Furthermore, "[a]ccording to assessments by the intelligence community of the United States, Iran continued in 2005 to test its medium-range ballistic missile, and the danger that Iran will acquire a nuclear weapon and integrate it with a ballistic missile Iran already possesses is a reason for immediate concern." *Policy of the United States on priorities in the development, testing, and fielding of missile defense capabilities*, Pub. L. No. 109-364, 120 Stat. 2130 (2006).

world. And God willing, with the force of God behind it, we shall soon experience a world without the United States and Zionism."[154]

As Lt. Col. Clayton Chun wrote in April 2000, "Those nations capable of producing an ASAT system at least equivalent to Program 437 and its Thor-class booster include Russia, North Korea (the Democratic People's Republic of Korea or DPRK), Iran, India, the People's Republic of China (PRC), and Libya."[155]

2. Kinetic Energy ASATs

Kinetic energy ASATs destroy satellites by directly colliding with them. They include interceptor missiles of various kinds, space mines (not yet developed, but conceived of for decades), and arguably, spacecraft that can be maneuvered into satellites.

The former USSR's main ASAT is the co-orbital satellite interceptor system—a large device, weighing over 4,400 pounds that is launched into orbit on an old SS-9 Intercontinental Ballistic Missile (ICBM).[156] This ASAT orbits the Earth a couple of times as it gradually approaches its target satellite.[157] When the ASAT is within a kilometer of the target it explodes into pellets directed towards the target satellite.[158] From 1968 until 1982, the USSR tested 20 of these interceptor satellites against target satellites. Target satellites were destroyed between 230 km to perhaps as high as 1,575

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[154] "Iranian leader: Wipe out Israel" *CNN International* (27 October 2005), online: CNN International <http://edition.cnn.com/2005/WORLD/meast/10/26/ahmadinejad/index.html> (accessed 24 June 2007).

[155] Chun, *Shooting Down a Star*, *supra* note 131 at 36.

[156] Kurt Gottfried & Richard Ned Lebow, "Anti-Satellite Weapons: Weighing the Risks" in Franklin A. Long, Donald Hafner & Jeffrey Boutwell, eds., *Weapons in Space* (New York: W. W. Norton & Company, 1986) 147 at 150.

[157] *Ibid.*

[158] *Ibid.*

km.[159] For some reason, however, the now-disbanded U.S. Office of Technology Assessment estimated that the Soviet system could destroy satellites up to an altitude of 5,000 km.[160] In August 1983, the USSR stopped the testing of its co-orbital satellite interceptor system in what has been called a "self-imposed moratorium."[161]

The use of a co-orbital satellite ASAT had previously been explored by the U.S. in its first ASAT program.[162] In the 1950's, the U.S. developed project SAINT (SAtellite INTerceptor)—a satellite that was designed to enter orbit, intercept, inspect and destroy a satellite.[163] SAINT ASATs were never produced—they never made it past research and development when the project was cancelled in 1962.[164] Instead, until 1975, the U.S. pursued its nuclear-armed Thor and Nike-Zeus ASAT programs.

In 1985, U.S. President Ronald Reagan notified Congress of his intent to test a new ASAT weapon.[165] Speaking of the USSR's co-orbital interceptor system, he noted, "[t]he USSR has the world's only operational ASAT system with an effective capability

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[159] The Soviets succeeded in destroying satellites up to 1005 km (on both 4 Apr 71 and 14 Mar 1981). The Soviet test of 17 Jun 97 against a satellite at 1,575 km was deemed a success, though it is uncertain both as to whether it was successful and also at the altitude of the attempted intercept. Out of the 20 Soviet tests, between 20 Oct 68 and 18 Jun 82, nine were deemed to have probably been successful. Michael O'Hanlon, *Neither Star Wars nor Sanctuary: Constraining the Military Uses of Space* (Washington D.C.: Brookings Institution Press, 2004) at 10-11.

[160] U.S., Office of Technology Assessment, Anti-Satellite Weapons, Countermeasures, and Arms Control (1985) at 11 [U.S., *Office of Technology Assessment Report*].

[161] *Ibid.* at 10. It is important to note, however, that though the USSR had proposed a "moratorium" on testing new ASATs, they were unwilling to dismantle their current ASAT program—which some call the world's only currently operational ASAT program. Stares, *supra* note 49 at 197.

[162] Donald L. Hafner, "Averting a Brobdingnagian Skeet Shoot: Arms Control Measures for Anti-Satellite Weapons" (Winter 1980-1981) 5:3 *International Security* 41 at 45 [Hafner, "ASAT Arms Control"].

[163] *Ibid.* at 45. See also Chun, *Defending Space, supra* note 11 at 36.

[164] Hafner, "ASAT Arms Control", *supra* note 162 at 45.

[165] U.S., *Cong. Rec.*, vol. 131, 108, at H7248 (4 September 1985).

to seek and destroy critical U.S. space systems in near-earth orbit."[166] Days later, the U.S. tested an ASAT program known as the Air-Launched Miniature Vehicle (ALMV). The ALMV is launched from an F-15 fighter jet on a two-stage rocket.[167] In contrast to Russia's co-orbital ASAT, the ALMV never enters into an orbit, but proceeds directly from the F-15 to the path in front of the target satellite, which is destroyed by the high-speed collision with the ALMV.[168] The ALMV was successfully tested on 13 September 1985. An F-15 released its missile at about 10 km above the Earth and the missile was propelled into the U.S.'s Solewind P78-1 satellite, which was in orbit approximately 500 km above the Earth's surface.[169] On impact, the ALMV, traveling at a speed of 10 km per second, shattered the Solewind satellite into more than 200 pieces.[170] The USAF had planned to purchase 112 of these ASATs for use on 20 F-15A jets but from 1985 to 1988 Congress largely banned the testing of this ASAT in space. Specifically, in 1984, the U.S. Congress passed a law that prevented any of the funds it had appropriated to the Department of Defense from being used to "test against an object in space the miniature homing vehicle (MHV) anti-satellite warhead launched from an F-15 aircraft unless the President determines and certifies to Congress" four requirements: (1) that he was endeavoring to reach an agreement with the USSR limiting ASAT weapons; (2) that

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[166] *Ibid.*

[167] The first stage is propelled by an AGM-69 Short-Range Attack Missile, while the second stage of propulsion is via a Thiokol Altair rocket. Hence, it has been noted as a "missile" by some sources and a "rocket" by others—both characterizations are accurate depending on the stage of propulsion being addressed. Bhupendra Jasani, "Space Weapons—Technical Aspects" in Bhupendra Jasani, ed. *Space Weapons and International Security* (Oxford: Oxford University Press, 1987) 14 at 15-16 [Jasani, "Space Weapons"].

[168] Gottfried & Lebow, *supra* note 156 at 151-52.

[169] Jasani, "Space Weapons", *supra* note 167 at 16-17.

[170] *Ibid.* at 17.

pending the agreement with the USSR, testing the ALMV against objects in space was "necessary to avert clear and irrevocable harm to the national security;" (3) "that such testing would not constitute an irreversible step that would gravely impair prospects for negotiations on anti-satellite weapons;" and (4) that any testing would be consistent with U.S. obligations under the 1972 *Anti-Ballistic Missile Treaty.*[171]

In 1985, Congress again included similar language restricting the testing of the ALMV unless the President made determinations and certifications to Congress as provided in the previous year's restriction.[172] Then, in 1986, Congress legislated a moratorium on ASAT testing, specifically, "[t]he Secretary of Defense may not carry out a test of the Space Defense System (anti-satellite weapon) against an object in space until the President certifies to Congress that the Soviet Union has conducted, after the date of the enactment of this Act, a test against an object in space of a dedicated anti-satellite weapon."[173] In 1987 Congress yet again passed a law against the testing of the ALMV against an object in space unless the USSR first tested an ASAT against an object in space.[174] In 1988, the USAF withdrew its request for funding of this ASAT and it has never again been used or tested.[175] The USSR was reportedly working on a similar ASAT, launched from a MiG-31 jet, but this ASAT was never tested.[176]

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[171] *Policy governing the testing of anti-satellite warheads*, Pub. L. No. 98-473, 98 Stat. 1941 (1984).

[172] *Testing of anti-satellite weapons and space survivability program*, Pub. L. No. 99-145, 99 Stat. 610 (1985).

[173] *Limitation on testing of anti-satellite weapons; expiration*, Pub. L. No. 99-661, 100 Stat. 3847 (1986).

[174] *One-year United States moratorium on testing antisatellite weapons*, Pub. L. No. 100-180, 101 Stat. 1048 (1987).

[175] Directory of U.S. Military Rockets and Missiles, "Vought ASM-135 ASAT" <http://www.designation-systems.net/dusrm/m-135.html> (accessed 11 May 2007).

[176] "Space Security Index 2006", *supra* note 18 at 424.

At a cost of about $350 million, from 1989 through 2004, the U.S. Army pursued a kinetic-energy ASAT program (KE ASAT).[177] The program consisted of using a rocket booster (a Minuteman-class booster) to launch a kinetic-kill vehicle, capable of destroying any satellite in Low Earth Orbit.[178] The kinetic-kill vehicle was to separate from the booster, track the target satellite, and hit and disable the target satellite with a sheet of Mylar plastic—that could hit the target satellite without shattering it and hence, was supposed to avoid creating a lot of debris.[179] The KE ASAT program was terminated in 1993, but continued to receive congressional funding in 1996, 1997, 1998, 2000, 2001 and 2004.[180]

For nearly 20 years, (from 13 Sep 85 until 7 Jul 05) there was no testing of kinetic energy ASATs. This ended on 7 Jul 05, when China unsuccessfully tried to impact one of their satellites with a solid-fuel, medium-ranged missile (SC-19). They tried again on 6 Feb 06. This test was also unsuccessful. Then on 11 Jan 07, China tried again. This time they successfully intercepted one of their old weather satellites, the Feng-Yun 1C, at an altitude of 865 km, exploding the satellite into thousands of pieces of debris.[181]

China's recently-demonstrated capability to target and destroy a satellite in Low Earth Orbit with a kinetic-based ASAT was demonstrably more advanced than the U.S.

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[177] J. Michael Waller, "Militarizing Space" *Insight Magazine* (24 February 2001), online: Free Republic <http://www.freerepublic.com/forum/a3a983e8b6928.htm> (accessed 1 July 2007).

[178] William L. Spacy II, *Does the United States Need Space-Based Weapons?* (CADRE Paper, Maxwell AFB, AL: Air University Press, 1999) at 61, online: Air University <http://www.au.af.mil/au/awc/awcgate/saas/spacey_wl.pdf> (accessed 1 July 2007).

[179] "Space Defense" (9 March 1997) online: Federation of American Scientists <http://www.fas.org/spp/military/program/asat/overview.htm> (accessed 1 July 2007).

[180] "Space Security Index 2006", *supra* note 18 at 425.

[181] Marc Kaufman & Dafna Linzer, "China Criticized for Anti-Satellite Missile Test" *The Washington Post* (19 January 2007) A01, online: The Washington Post <http:// www.washingtonpost.com/wp-dyn/content/article/2007/01/18/AR2007011801029.html> (accessed 10 July 2007).

Department of Defense had reported to the U.S. Congress in 2006: "China can currently destroy or disable satellites only by launching a ballistic missile or space-launch vehicle armed with a nuclear weapon."[182] Marine General James E. Cartwright, Commander of U.S. Strategic Command, commented on how remarkable China's ASAT capability was, "What was impressive was that in three attempts, they made significant changes each time."[183] Not only was China's ASAT capability more advanced than the U.S. thought it was, its capability was more than what either the U.S. or Russia had demonstrated before—this was the first successful ASAT by a land-based missile ever.[184] It is no wonder that Air Force Chief of Staff, General Michael T. Moseley, compared China's ASAT shootdown with the USSR's launch of Sputnik in October of 1957—when the USSR demonstrated that they had were "ahead" of the U.S. in the space race.[185] Alexander Khramchikhin, head of the analytical department for Political and Military Analysis in Moscow, echoed the sentiments of these U.S. generals, noting that China's ASAT test shows that Beijing has more advanced space weapons than either the U.S. or Russia.[186] General Peter Pace, the Chairman of the Joint Chiefs of Staff, said of China's test, "it is a unique capacity in the world. And we need to, in a very separate conversation, take a look at where are we with regard to that capacity, where should we

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[182] U.S., Department of Defense, *Annual Report to Congress: Military Power of the People's Republic of China* (2006) at 35, online: U.S. Department of Defense Publications <http://www.defenselink.mil/pubs/china.html> [U.S., *2006 Report on China*] (accessed 5 July 2007).

[183] Peter Spiegel, "U.S. gauges the threat to satellites" *Los Angeles Times* (22 April 2007) A26.

[184] Eric Talmadge, "China ready—and able—to face U.S. in space" *The Commercial Appeal* (15 April 2007) A10. See Isenberg, *supra* note 5 at 1.

[185] Bill Gertz, "Pentagon details China's new military strategies" *The Washington Times* (25 May 2007) A14.

[186] Dmitry Litovkin, "China's anti-satellite weapons a warning to Russia and the U.S." *Russian Press Digest* (13 February 2007).

be, and if there is a gap, how we close it."[187] Finally, the Secretary of the USAF noted, "Recent foreign testing of kinetic ASAT weapon capabilities further demonstrates an explicit willingness to challenge, disrupt, or destroy America's space assets and capabilities."[188]

The Chinese had successfully employed the advice of Deng Xiaoping, the former de facto leader of China from the late 1970's to the early 1990's, "hide our capacities and bide our time; be good at maintaining a low profile." Ironically, this quote was found in the same report by the U.S. Department of Defense that noted China did not have ASAT capability beyond the use of a nuclear weapon.[189]

Another type of ASAT that could be characterized as a kinetic-energy ASAT, depending on its use, is a "parasitic" ASAT or a "piggyback satellite." These ASATs attack their target satellite by attaching themselves to it and then either blowing them up, or, alternatively, merely jamming the target satellite. China has been working on developing these types of ASATs.[190]

In January 2003, the USAF tested its XSS-10 microsatellite (Experimental Small Satellite), which maneuvered within 35 meters of other satellites in order to take

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[187] "US Defense Chief Troubled by Chinese Anti-Satellite Test" *Washington* (6 February 2007), online: Space Daily <http://www.spacewar.com/reports/US_Defense_Chief_Troubled_By_Chinese_Anti_Satellite_Test_999.html> (accessed 4 June 2007).

[188] U.S., *FY 2008 National Defense Budget Request from the Department of the Air Force Before the House Armed Services Committee*, 110th Cong. (28 February 2007) at 3 (The Honorable Michael W. Wynne & General T. Michael Moseley), online: House Armed Services Committee <http://armedservices.house.gov/hearing_information.shtml> (accessed 10 June 2007).

[189] U.S., *2006 Report on China*, *supra* note 182 at 7.

[190] Liao, *supra* note 74 at 209.

pictures.[191] Rather than equipping the XSS-10 with a camera, a small explosive could easily be used to destroy a target satellite from that range.[192] In April 2005, the USAF launched the XSS-11, the successor to the XSS-10. The U.S. vaguely registered this satellite in the U.N. Registry as a "[s]pacecraft engaged in practical applications and uses of space technology such as weather and communications."[193] An anonymous Department of Defense official, however, commented about this highly-maneuverable microsatellite, "XSS-10 and -11 [were] both designed for the same mission. XSS-11 can be used as an ASAT weapon."[194]

Some have also indicated the position that the U.S. Space Shuttle is also an anti-satellite weapon, as it "could" be used as one.[195] This is akin to saying a fork is a weapon, because it "could" be used as one. Nevertheless, as it has been labeled as a potential ASAT by numerous sources, including the former U.S. Office of Technology Assessment,[196] I will include it here. Any space-launch vehicle *could* be used as an ASAT. This highlights the problem of trying to define an ASAT, a central starting point for any proposed arms control agreement.

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[191] Bruce M. DeBlois, *et al.* "Space Weapons: Crossing the U.S. Rubicon" (Fall 2004) 29:2 *International Security* 50 at 59.

[192] *Ibid.*

[193] "Online Index of Objects Launched into Outer Space" online, United Nations <http://www.unoosa.org/oosa/osoindex.html> (accessed 10 July 2007).

[194] Elaine M. Grossman & Keith J. Costa, "Small, Experimental Satellite May Offer More than Meets the Eye," *Inside the Pentagon* (4 December 2003), online: Global Security.org <http://www.globalsecurity.org/org/news/2003/031204-asat.htm> (accessed 17 June 2007).

[195] During negotiations with the U.S. in the 1970's over a potential ASAT treaty, "the Soviet Union included the space shuttle on its list of what is considered U.S. ASAT hardware." Joan Johnson-Freese, *Space as a Strategic Asset* (New York: Columbia University Press, 2007) at 34. See also, Allan Rosas, "The Militarization of Space and International Law" (1983) 20:4 *Journal of Peace Research* 357 at 357.

[196] "The existence of non-ASAT weapons (e.g., ICBMs, ABMs) and space systems (e.g., maneuverable spacecraft) with some inherent ASAT capability makes it impossible to ban the ability to attack satellites." U.S., *Office of Technology Assessment Report, supra* note 160 at 16.

3. Directed-Energy Weapons

A laser[197] beam travels at the speed of light—300,000 km/s (186,000 miles per second);[198] hence, it would only take a small fraction of a second for a laser from Earth to reach any of the artificial satellites orbiting the Earth. Lasers have been contemplated for both "blinding" (permanently damaging) or "dazzling" (temporarily blinding) satellites.[199] For a laser to be an effective weapon against a satellite, the operator would need to keep the weapon focused on the target satellite long enough to build up sufficient heat.[200] Focusing the laser on the target satellite, and keeping the laser on the satellite long enough to damage it, is not a simple feat, as satellites in Low Earth Orbit are traveling at 7-8 kilometers per second.[201] The dangers of such ASATs, if developed, are substantial—as these weapons would provide "an 'all altitude,' 'instantaneous kill' capability."[202] The U.S., Russia and China all currently have laser-based ASAT capabilities.[203]

The largest U.S. experimental chemical laser, the Mid-Infrared Advanced Chemical Laser (MIRACL), was developed as a defense against anti-ship cruise missiles. MIRACL is a chemical laser that was designed to destroy its target by heating it with a

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[197] "Laser" is an acronym for "**L**ight **A**mplification by **S**imulated **E**mission of **R**adiation." Stares, *supra* note 49 at 111.

[198] DeBlois, *supra* note 191 at 58.

[199] *Ibid.*

[200] Chun, *Defending Space*, *supra* note 11 at 34.

[201] Detlev Wolter, *Common Security in Outer Space and International Law* (Geneva, Switzerland: UNIDIR, 2006) at 34.

[202] U.S., *Office of Technology Assessment Report*, *supra* note 160 at 12.

[203] Chun, *Defending Space*, *supra* note 11 at 34.

beam of infrared radiation.[204] In 1997, the US tested this chemical laser against a U.S. satellite in orbit. The test involved two lasers, the high-power MIRACL laser and a low power 30-watt laser used for alignment. The laser hit a target 260 miles from Earth. Reportedly, it was the 30-watt laser that actually damaged the target satellite's sensors, causing concern that perhaps even commercially available lasers could be used to "dazzle" (temporarily disrupt) satellites.[205]

The U.S. Department of Defense has recognized that China has been working on a ground-based laser ASAT "designed to damage or blind imaging satellites."[206] In October of 2006, the Director of the U.S. National Reconnaissance Office, Donald Kerr, reported that China had illuminated U.S. spy satellites flying over China with a ground-based laser.[207] No indication was given as to when this happened, or how many times. China's illumination of the U.S. satellite did not, however, materially damage its ability to collect information.[208] According to a slideshow presentation by Colonel Rick Patenaude of Air Force Space Command, "In two hours of function, an anti-satellite laser within the projected technical capability of China could: Destroy 12 NAVSTAR [GPS] satellites".[209]

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[204] O'Hanlon, *supra* note 159 at 71.

[205] "Space Security Index 2006", *supra* note 18 at 427.

[206] U.S., *2006 Report on China*, *supra* note 182 at 35.

[207] "China Jamming Test Sparks U.S. Satellite Concerns" USA Today Online Edition (5 October 2006), online: USA Today <http://www.usatoday.com/tech/news/2006-10-05-satellite-laser_x.htm> (accessed 14 May 2007).

[208] *Ibid.*

[209] U.S., Colonel Rick Patenaude, "Prompt Global Strike Update" (August 2005), slide 5, online: Arms Control Wonk.com <http://www.armscontrolwonk.com/1455/asats-and-crisis-instability> (accessed 26 June 2007).

Russia has worked on laser ASAT capabilities since the 1970's. Soviet lasers have targeted several U.S. satellites in the past, "blinding" an early-warning satellite on five occasions in 1975 and targeting ("painting") it again several times between 1983 and 1984.[210] The Soviets also "painted" and permanently damaged a U.S. reconnaissance (Keyhole) satellite in 1976.[211] On 10 October 1984, the USSR also targeted the U.S. Space Shuttle Challenger, causing equipment to malfunction and temporarily blinding the crew.[212] The U.S. also believed the USSR to be "conducting research and development in the area of space-based laser ASAT systems."[213]

One defensive capability the U.S. is pursing that could likely be modified for use as an ASAT is the Airborne Laser (ABL), a program begun by the USAF in 1996.[214] This laser "will locate and track missiles in the boost phase of their flight, then accurately point and fire the high-energy laser, destroying enemy missiles near their launch areas."[215] The ABL laser is mounted on the nose of a modified 747 aircraft. Boeing's website notes that the first missile intercept test will take place in late 2008.[216]

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[210] Desmond Ball, "Assessing China's ASAT program" (14 June 2007), online: Nautilus Institute <http://www.nautilus.org/~rmit/forum-reports/0714s-ball/> (accessed 27 June 2007).

[211] *Ibid.*

[212] *Ibid.*

[213] U.S., *U.S. Policy on ASAT Arms Control: Communication from the President of the United States Transmitting a Report on his Administration's Policy on Arms Control for Antisatellite Systems as Required in the Conference Report for the Department of Defense Appropriations Act for FY 1984* (H. Doc. No. 98-197)(Washington, D.C.: United States Government Printing Office, 1984) [U.S., *Policy on ASAT Arms Control*].

[214] For a discussion of the modifications necessary to turn the ABL into an ASAT (e.g., the differences in target acquisition and tracking of a satellite versus liquid-fueled rockets and missiles), see O'Hanlon, *supra* note 159 at 73-76.

[215] "Integrated Defense Systems: Airborne Laser (ABL)" online: Boeing <http://www.boeing.com/defense-space/military/abl/index.html> (accessed 14 May 2007).

[216] *Ibid.*

In 2003, the USAF listed a "Space-Based Radio Frequency Energy Weapon" as a "future system concept" and noted it would "be a constellation of satellites containing high-power radio-frequency transmitters that possess the capability to disrupt/destroy/disable a wide variety of electronics and national-level command and control systems. It would typically be used as a non-kinetic anti-satellite weapon."[217]

4. Jamming

One way to temporarily disable the operational effectiveness of a satellite without having to destroy it is to employ electronic countermeasures against the satellite. "Jamming" consists of "overloading enemy receivers with strong signals"[218] Another electronic countermeasure is "spoofing," which consists of sending deceptive signals.[219]

As of September 2004, the USAF has operated the Counter Communications System.[220] Operated by the 76th Space Control Squadron in Colorado, this system uses mobile antennas to jam an adversary's access to space.[221] Speaking of this program, Peter Teets, former Acting Secretary of the USAF and the Director of the National Reconnaissance Office noted, "[t]his system is designed to apply reversible effects that ensure that during a time of need, an adversary's space-based capability to threaten our forces is diminished. Following the time of need, those space-based capabilities can be

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[217] U.S., *Transformational Flight Plan, supra* note 52 at D-10.

[218] U.S., *Office of Technology Assessment Report, supra* note 160 at 9.

[219] *Ibid.*

[220] Jim Wolf, "U.S. deploys satellite jamming system" *The San Diego Union-Tribune* (29 October 2004), online: SignonSanDiego.com <signonsandiego.com/news/military/20041029-1531-arms-satellite-usa.html> (accessed 23 June 2007).

[221] David A. Fulghum & Amy Butler, "Reassessing Space: U.S. Eyes China Asat Fallout; U.S. analysts sort through the fallout from China's satellite shoot-down" (2007) 166:17 AW&ST 27.

returned to their original state."[222] U.S. "budget documents indicate 'first generation' counter satellite communications capabilities are already in place, while the 'second-generation' capability will be built by 2011."[223]

The U.S., Russia, China, Iran, Cuba, Iraq and North Korea all have military jamming capabilities.[224] For example, during Operation IRAQI FREEDOM (OIF), Iraqi forces used GPS jammers in their failed attempt to jam the U.S. GPS system.[225]

The capability for "jamming" satellite transmissions is not limited to a few select countries. In 1997, Tonga accused Indonesia of jamming the broadcast of transmissions from a Hong Kong satellite (Apstar 1A).[226] In July 2003, Iran "jammed" a U.S. Geostationary satellite from a location inside of Cuba.[227] The satellite had been broadcasting U.S. government and private Persian-language television and radio broadcasts into Iran.[228] In 2005, Libya successfully jammed broadcasts from a couple of international satellites. The target of the jamming was thought to be the program *Sowt Libya* "a British- and Arab-owned commercial radio station broadcasting on human rights

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[222] "Persistent Director: Interview with Peter Teets" 3:1 *Military Geospatial Technology: Online Edition* (17 March 2005), online: Military Geospatial Technology <http://www.military-geospatial-technology.com/article.cfm?DocID=856> (accessed 24 June 2007).

[223] Hampton Stephens, "Pentagon's Plans for 'Space Control'", online: (2007) DefenseTech.org <http://www.defensetech.org/archives/003217.html> (accessed 23 June 2007).

[224] U.S., *Space Commission Report*, *supra* note 151 at 19.

[225] U.S., *Space Operations*, *supra* note 79 at 33. See Chun, *Defending Space*, *supra* note 11 at 54.

[226] Tom Wilson, "Threats to United States Space Capabilities" (Paper for the Commission to Assess United States National Security Space Management and Organization) online: Federation of American Scientists <http://www.fas.org/spp/eprint/article05.html> (accessed 19 June 2007).

[227] J. Michael Waller, "Homeland Insecurity: Iran, Cuba Zap U.S. Satellites: Official Likens Communications Jamming to 'Act of War'" *WorldNetDaily* (7 August 2003), online: WorldNetDaily <http://www.wnd.com/news/article.asp?ARTICLE_ID=33957> (accessed 14 May 2007).

[228] *Ibid.*

issues to Libya."[229] The jamming not only jammed the signals of CNN International, BBC World and other stations, but also disrupted U.S. military communications in the Mediterranean.[230]

Jamming a satellite's signal does not require expensive or high-tech capability. In fact, Russia markets handheld GPS jammers the size of a cigarette package with the capability of denying access to GPS for 80 kilometers.[231] GPS jammers, and designs to build GPS and communications jammers, are readily available for purchase on the Internet.[232] A rather famous case of low-technology jamming took place inside the U.S. in April of 1986 when "Captain Midnight" overrode an HBO broadcast with a text message protesting HBO's rates for satellite viewers.[233]

China has had its share of intentional satellite disruptions from non-State actors. In 2002, the Falun Gong (a banned spiritual group or evil cult, depending on who you ask) not only jammed regularly programmed satellite signals, but took them over.[234] The Falun Gong interrupted scheduled Chinese entertainment and educational T.V. broadcasts with messages promoting the Falun Gong for over an hour.[235] Three years later, in March 2005, signals allegedly sent by the Falun Gong interrupted "at least eight television stations with anti-government messages timed to coincide with annual

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[229] "Space Security Index 2006", *supra* note 18 at 433.

[230] *Ibid.* at 433-34.

[231] U.S., *Space Commission Report*, *supra* note 151 at 20.

[232] U.S., *Transformational Flight Plan*, *supra* note 52 at 61.

[233] James R. MacDougall, "Just Who is Captain Midnight" online: MacDougall Electronics <http://www.macdougallelect.com/bio.html> (accessed 23 June 2007).

[234] Hamish McDonald, "Falun Gong invades China's TV air space" (5 October 2002) online: The Age <http://www.theage.com.au/articles/2002/10/04/1033538773097.html> (accessed 23 June 2007).

[235] *Ibid.*

meetings of the Chinese Communist Party."[236] China's response was to purchase and develop "jam-proof" satellites—but signals from a supposedly "jam-proof" satellite were also overridden by the Falun Gong in July 2005.[237]

If the Falun Gong and "Captain Midnight" have this capability, it is reasonable to conclude that most States and other non-State actors (e.g., al Qaeda) could fairly easily obtain some level of satellite jamming capabilities.

5. Ballistic Missile Defense

Ballistic missile defense (BMD) is closely related to ASATs in two ways. First, the absence of a defense against a potential adversary's ballistic missiles will keep a State from launching its own ballistic missiles (for fear of retaliation). If a State were to begin developing a space-based defense to the strategic weapons of its potential adversaries, they would likely feel the need to develop the means to attack this space-based missile defense—resulting in a sharp increase in ASAT development by all potential adversaries. Second, BMD has inherent ASAT capabilities.[238] The U.S.'s former Office of Technology Assessment confirmed this in 1985, "even a modest BMD system would

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[236] "Space Security Index 2006", *supra* note 18 at 434.

[237] *Ibid.* at 434-35.

[238] David Wright, Laura Grego & Lisbeth Gronlund, "The Physics of Space Security: A Reference Manual" (10 August 2005) online: Union of Concerned Scientists <http://www.ucsusa.org/global_security/space_weapons/policy-implications-of-space-weapons.html> (accessed 25 June 2007).

make a very capable ASAT weapon ...."[239] This is the case even if the BMD system is only designed to attack an object while it is in its launch phase.[240]

Some dispute that BMD could be used as an ASAT—noting that targeting a satellite requires totally different technology than targeting a ballistic missile. James Oberg, a veteran of NASA mission control, noted that a space-based missile interceptor system that targets a missile during its boost phase "relies on chasing down its most visible feature: its hot rocket plume."[241] By comparison, "satellites don't have hot rocket plumes, and sensors developed to chase such plume generators (i.e., attacking missiles) wouldn't even see a passively orbiting satellite."[242]

There are several responses to this argument. First, all satellites use rockets to launch them into space. If a State builds a system capable of destroying a satellite in the early stages of its launch towards space, such a system would be an effective ASAT—and would control access to space. Second, the U.S.'s current missile defense program is not merely seeking a method to attack a rocket in its boost phase, but rather "[t]he program is managed as one system that will explore concepts and eventually develop and field air, sea, ground and space systems that will intercept any range of threat in the

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[239] U.S., *Office of Technology Assessment Report, supra* note 160 at 19. "All space-based and many ground-based BMD weapons would make excellent ASATs, even if they were poor strategic defenses." Donald L. Hafner, "Negotiating Restraints on Anti-Satellite Weapons: Options and Impact" in Joseph S. Nye and James A. Schear, eds., *Seeking Stability in Space: Anti-Satellite Weapons and the Evolving Space Regime* (Lanham, MD: University Press of America, 1987) 87 at 91.

[240] "An effective boost-phase BMD would also be a potent [Low Earth Orbit] ASAT, and it makes no sense to imagine stringent bans on [a Low Earth Orbit] ASAT coexisting with unbridled testing of Star Wars defense systems." Ashton B. Carter, "Satellites and Anti-Satellites: The Limits of the Possible" (Spring, 1986) 10:4 International Security 46 at 96.

[241] James Oberg, "The dozen space weapons myths", online: (23 March 2007) The Space Review at para. 5 <http://www.thespacereview.com/article/826/1> (accessed 26 June 2007).

[242] *Ibid.*

boost, midcourse or terminal phases of flight trajectory."[243] This type of missile defense affords a better chance at interception, as the missile can be subject to multiple attacks over the course of its trajectory—even while it is in space.[244] In fact, as Air Force Lieutenant General Henry A. Obering III, the Director of the U.S. Missile Defense Agency, recently stated, "[t]he system's Ground-Based Interceptors use hit-to-kill technologies to destroy intermediate- and long-range ballistic missile warheads in space, in the midcourse phase of flight. These are the only weapons we have available today to defeat longer-range threats once they have been launched."[245] The missile defense system the U.S. is currently developing will have definite ASAT capabilities.

Russia also has a limited ballistic missile defense program (within the confines of the now-deceased *Anti-Ballistic Missile Treaty*[246]) that protects Moscow from an attack by ballistic missiles. Russia's ABM interceptors "can climb to several hundred kilometers altitude, where its multi-megaton nuclear warhead could harm normal satellites hundreds of kilometers away."[247]

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[243] U.S., *Costs by Weapon System*, *supra* note 37 at 78. The plan for a layered defense (attacking ballistic missiles in all phases of their flight) has been around for a long time. See, Lt. Gen. Daniel O. Graham, *High Frontier: A New National Strategy* (Washington D.C.: High Frontier, 1982) at 24.

[244] Independent Working Group, *supra* note 134 at 11-12.

[245] U.S., *Missile Defense Program and FY2008 Budget before the Strategic Forces Subcommittee, House Armed Services Committee,* 110th Cong. (27 March 2007) at 7 (Lieutenant General Henry A. Obering III, USAF), online: Missile Defense Agency <http://www.mda.mil/mdalink/pdf/hasc032607.pdf> (accessed 26 June 2007).

[246] "Each party undertakes not to deploy ABM systems or their components except that: (a) within one ABM system deployment area having a radius of one hundred and fifty kilometers and centered on the Party's national capital, a Party may deploy: (1) no more than one hundred ABM launchers and no more than one hundred ABM interceptor missiles at launch sites ...." *Treaty on the Limitation of Anti-Ballistic Missile Systems*, 26 May 1972, U.S.-USSR, 23 U.S.T. 3435, art. III(a) [*Anti-Ballistic Missile Treaty*].

[247] Carter, *supra* note 240 at 75. See U.S., *Policy on ASAT Arms Control*, *supra* note 213 at 14.

B. Vulnerability to ASATs

Of the 847 active satellites in space, 470 belong to the U.S. or its companies (or are listed as "international" or "multinational" and have strong ties to the U.S.).[248] Of the U.S.'s 470 satellites, 123 are military satellites (omitting the civilian satellites, such as Iridium, that the U.S. military also uses).[249] Major General Frank Faykes, Director of the USAF Budget, recently reported that the Air Force "[c]onducts space control and satellite operations of over 140 DoD [Department of Defense] and National Satellites".[250] Regardless, the exact numbers of satellites, military or otherwise, the U.S. investment in its satellites is valued at over $50 billion dollars.[251]

Russia and China have the second and third most satellites in space, with 91 and 39 respectively.[252] Given these simple numbers, it's plain to see who has the most assets in space, and hence both the most to gain from space, but also the most to lose in space. As stated in the *Space Commission Report*, "[t]he U.S. is more dependent on space than any other nation."[253]

"It is a rule in strategy, one derived empirically from the evidence of two and half millennia, that anything of great strategic importance to one belligerent, for that reason has to be worth attacking by others."[254] Or, as noted in the *Space Commission Report*,

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[248] UCS Satellite Database, *supra* note 17.

[249] *Ibid.*

[250] It is likely that the "National Satellites" included some of the non-military governmental satellites listed in the UCS Satellite Database. Faykes, *supra* note 52 at slide 41.

[251] U.S., Chilton Testimony, *supra* note 80 at 7.

[252] UCS Satellite Database, *supra* note 17.

[253] U.S., *Space Commission Report*, *supra* note 151 at 18.

[254] Colin S. Gray, *Another Bloody Century: Future Warfare* (London: Weidenfeld & Nicholson, 2005) 307.

the U.S. recognizes that the "political, economic and military value of space systems makes them attractive targets for state and non-state actors hostile to the United States and its interests."[255]

The impact from the destruction of these satellites would be tremendous—politically, economically, socially and militarily. "Without space-based communications and precision location our military forces would degrade. This would not be the quasi-linear degradation under fire that traditional combat elements experience, but a non-linear degradation—one approaching an order of magnitude reduction in capability."[256]

Satellites, given their enormous military and economic importance, are certainly attractive targets—but they are only at risk inasmuch as an enemy can target them. After all, satellites move at extremely fast speeds and are far, far away. That said, satellites move in predictable orbits, so enemies with technical sophistication will know where a State's satellites are at any given time.[257] As an article in China's *Liberation Army Daily* noted, "Anti-satellite weapons that can be developed at low cost and that can strike at the enemy's enormously expensive yet vulnerable space system will become an important option for the majority of medium-sized and small countries with fragile space technology."[258]

The preceding discussion of ASATs shows that at least the U.S., Russia and China possess a demonstrated ability to specifically target and destroy at least satellites in

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[255] U.S., *Space Commission Report*, *supra* note 151 at 17.

[256] William A. Shields, USAF Brig. Gen. (ret.). "The Danger of ASATs" (9 April 2007) 166:14 AW&ST 6.

[257] Gray, *supra* note 254 at 299-300.

[258] Roger Cliff et al., Entering the Dragon's Lair: Chinese Antiaccess Strategies and Their Implications for the United States (Santa Monica: RAND, 2007) at 57-58, online: RAND <http://www.rand.org/pubs/monographs/MG524> (accessed 10 July 2007).

Low Earth Orbit (which would include reconnaissance satellites, communications satellites, weather satellites and space stations).

More concerning is the growing numbers of States that are capable of detonating a nuclear warhead a few hundred kilometers above ground (including North Korea, and likely soon, Iran).[259] With this basic capability, there is no need for the technology to specifically target a fast moving satellite—once they have a nuclear warhead and a rocket capable of reaching a few hundred kilometers up, they don't need to specifically target anything to basically destroy everything in Low Earth Orbit. An attack of this kind, and from its resulting electromagnetic pulse (EMP), would have effects much greater than those experienced in Hawaii after the STARFISH Prime test of 1962. Societies rely on electronics much more in 2007 than they did in 1962—including many aspects of critical infrastructure—water supply, power, fuel, communications, transportation, government services, financial services and emergency services.[260]

Though not nearly as catastrophic as a nuclear explosion in Low Earth Orbit, even "jamming" can have dire consequences. GPS signals from satellites in Medium Earth Orbit are highly susceptible to jamming. GPS signals are very weak—so weak that they are "regularly wiped out by natural phenomena and by other radio transmissions. And anyone with $50 and a soldering iron can buy parts from a radio store and make a jammer to destroy the GPS signal for a hundred miles."[261] With such availability and having such a low price tag, the potential for use by terrorists is concerning.

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[259] Iran has tested whether its ballistic missiles could be exploded by remote control while they are still in high-altitude flight. Independent Working Group, *supra* note 134 at 10.

[260] *Ibid.* at 9.

[261] Langhorne Bond, "The GNSS Safety and Sovereignty Convention of 2000 AD" *A paper delivered to Global Airspace 99* (3 February 1999) online: International Loran Association

C. Defending Satellites from ASATs

There are several ways to reduce satellite vulnerabilities. Important satellite systems can be equipped with a variety of survivability features. For example, they can be hardened to prevent destruction from a distant nuclear attack, made resistant to warming from distant lasers, and provided with anti-jamming capabilities.[262] The U.S. GPS satellites are equipped with these survivability features and several others.[263]

Another way to reduce the vulnerability of satellite systems is to keep spare replacement satellites in orbit, so if one satellite in a satellite system is destroyed, another satellite would be readily available to take its place. This is also the case with the U.S.'s GPS satellites.[264]

One method of countering an ASAT attack is to have the ability to maneuver the targeted satellite out of the path of the ASAT. To be effective, the maneuver would have to take place after the ASAT had been launched, hence, a solid alerting system would have to be operational in order to warn of a pending attack in time for a successful evasion via a maneuver operation.[265] Besides needing advance warning, satellites are also constrained by how much fuel they have available.[266]

Yet another way to protect a satellite would be to give it "stealth" capabilities, much like the U.S. provides for its B-2 Stealth Bomber and the U.S. Navy provides its

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<http://www.loran.org/ILAArchive/LanghorneBondPapers/09GNSSSafetyAndSovereigntyRio2000.pdf> (accessed 9 July 2007).

[262] U.S., *Counterspace Operations*, *supra* note 130 at 26. See also, Carter, *supra* note 240 at 91.

[263] *Ibid.*

[264] *Ibid.* See U.S., *Counterspace Operations*, *supra* note 130 at 28.

[265] Carter, *supra* note 240 at 84. See also, *Counterspace Operations*, *supra* note 130 at 27.

[266] U.S., *Counterspace Operations*, *supra* note 130 at 27.

Virginia Class Submarine and will provide its planned Littoral Combat Ship.[267] Stealth minimizes energy reflection and maximizes energy absorption, making the satellite difficult to detect with radar, infrared, visual or acoustic sensors.[268]

Another contemplated method for protecting an important satellite is to have "bodyguard" satellites follow the protected satellite closely. The "bodyguard" satellite could then take action to negate any threat it might detect.[269]

This is but a sampling of the actions that can be taken by States to protect their satellites from ASAT attacks. These protective measures, however, are far from adequate guarantees for satellite safety. Stealth will not protect against a nearby nuclear detonation, nor will it prevent a satellite from being unintentionally struck by a piece of space debris. Maneuvering out of the path of an incoming ASAT may work against some ASAT threats, but this capability comes at the expense of burning up limited fuel. Anti-jamming technology will work against some jamming technologies, but as the Falun Gong demonstrated to China, the technology for jamming satellites will also get more effective. Anti-jamming measures will also be of no value in defending against non-jamming ASAT capabilities. Finally, hardening a satellite can only provide protection against distant nuclear blasts or tiny fragments of debris. All methods of physically protecting satellites have serious limitations.

Another measure of protection that could, arguably, be at least as effective as all of the above-mentioned "survivability" measures, would be to adopt an international

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[267] U.S., *Costs by Weapon System*, *supra* note 37 at 78.

[268] Adolfo J. Fernandez, "Military Role in Space Control: A Primer" (Cong. Research Service Report for Congress, 23 September 2004) at CRS-12, online: Federation of American Scientists <http://www.fas.org/man/crs/RL32602.pdf> (accessed 27 June 2007).

[269] *Ibid.* at CRS-13.

agreement limiting ASATs. Chapter Six of this thesis will discuss how such a treaty is desirable.

Having discussed current and planned ASAT capabilities, it is apparent that satellites are vulnerable to several kinds of attack. This is so, is spite of the limited "survivability" features that can be incorporated into satellites. That said, satellites, are only vulnerable if a State or other organization has the intent to employ them. Hence, it is important to consider, as best as can be discerned, the intentions of those who could carry out an ASAT attack.

Chapter Three: Future Intentions to Use ASATs

A. U.S. Intentions to Use ASAT Weapons

1. Military Doctrine

In 2001, a committee was appointed in the U.S. to access space activities in support of U.S. national security.[270] The committee, known as the "Space Commission," was made up of retired generals and congressmen, and was chaired by Donald H. Rumsfeld until his appointment as the Secretary of Defense. The conclusions of the Space Commission have been important to U.S. military doctrine regarding the use of space. The *Space Commission Report* highlighted the growing U.S. dependence on space and the potential that an adversary would attack U.S. space systems—referring to a potential "Space Pearl Harbor."[271] One specifically identified threat was China—citing a Chinese news agency report claiming, "China's military is developing methods and strategies for defeating the U.S. military in a high-tech and space-based future war."[272] As seen from China's January 2007 ASAT test, this report was accurate.

The *Space Commission Report* fatalistically noted, "every medium—air, land and sea—has seen conflict. Reality indicates that space will be no different."[273] The report noted that the U.S. would need to be able to deter and defend against attacks against its space assets.[274] The report concluded that "superior space capabilities" were required,

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[270] U.S., *Space Commission Report*, *supra* note 151 at vii.

[271] *Ibid.* at viii.

[272] *Ibid.* at 22.

[273] *Ibid.* at 100. "Space is a domain—like the air, land, sea, and cyberspace—within which military operations take place." U.S., *Space Operations*, *supra* note 79 at 3. "Future warfare will include war in space and cyberspace." Gray, *supra* note 254 at 308.

[274] U.S., *Space Commission Report*, *supra* note 151 at 100.

and suggested five measures to transform the U.S. space program: (1) recognize U.S. space interests as vital to national security; (2) re-arrange the Department of Defense to meet future national-security space needs; (3) ensure the Secretary of Defense and the Director of Central Intelligence work closely together on national space security programs; (4) *develop the means to deter and defend against attacks on U.S. assets in space*; and, (5) invest in space science and technology.[275]

In November 2003, the USAF published its *Transformational Flight Plan*—its plan to transform the Air Force from an industrial age Air Force to an information age Air Force, and from an Air Force focused on the Cold War, to one prepared for the post-Cold War period.[276] In regards to space, it largely adopted the *Space Commission Report* from two years earlier, and specifically noted it was "[i]mplementing the changes recommended" by the *Space Commission Report.*[277] The *Transformational Flight Plan* recognized the risks of future adversaries attacking U.S. space assets[278] and adopted the conclusion that the U.S. had to "develop the means both to deter and to defend against hostile acts in and from space."[279]

The *Transformational Flight Plan* asserted that it was essential to deny an adversary access to space services—to prevent them from using space "in the same way the United States and its allies can."[280] The plan went on to stress the need for

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[275] *Ibid.* at 99-100.

[276] U.S., *Transformational Flight Plan, supra* note 52 at i.

[277] *Ibid.* at iv.

[278] *Ibid.* at 60.

[279] *Ibid.* at 39.

[280] *Ibid.* at 61.

"offensive counterspace systems" capable of "negating adversarial space capabilities from low earth up to geosynchronous orbits."[281] It stressed, however, that "when practical" the U.S. would deny "adversary access to space on a temporary and reversible basis."[282] Hence, the U.S.'s preferred method of "offensive counterspace" will not be the permanent destruction of another State's satellites. This stance found its way into the 2006 Quadrennial Defense Review, which called for only reversible ASAT capabilities, like jamming, rather than kinetic-based ASATs.[283]

The *Transformational Flight Plan* noted the "Air Force Vision" challenged the Air Force to "maintain global air and space power supremacy".[284] The plan noted, "Space *superiority* combines the following three capabilities: protect space assets, deny adversaries' access to space, and quickly launch vehicles and operate payloads into space to quickly replace space assets that fail or are damaged/destroyed."[285] A 2006 USAF doctrine document, entitled, *Space Operations* defined "space superiority" as "[t]he degree of *dominance* in space of one force over another that permits the conduct of

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[281] *Ibid.*

[282] *Ibid.*

[283] Michael Bruno, "Senator: U.S. Offensive Space Abilities a Must" (30 January 2007) *Aerospace Daily & Defense Report*, online: "Aviation Week <http://www.aviationweek.com/aw/generic/story_channel.jsp?channel=space&id=news/KYL01307.xml> (accessed 10 June 2007). Despite Arizona Senator Jon Kyl's comments, my review of the 2006 Quadrennial Defense Review found no reference to "anti-satellite weapons" or "ASATs" and only a vague reference that "[s]urvivability of space capabilities will be assured by improving space situational awareness and protection, and through other space control measures." U.S., Department of Defense, *Quadrennial Defense Review Report*, (6 February 2006) at 56, online: U.S. Department of Defense Publications <http://www.defenselink.mil/pubs/> (accessed 9 July 2007). Perhaps these "other space control measures" were further spelled out in related documents Senator Kyl reviewed.

[284] U.S., *Transformational Flight Plan*, *supra* note 52 at 79.

[285] *Ibid.* at C11-12 [emphasis added].

operations by the former and its related land, sea, air, space and special operations forces at a given time and place without prohibitive interference by the opposing force."[286]

Space Operations also describes the four space mission areas. One of these mission areas includes "space control" which includes using ASATs to deny an adversary the ability to effectively use space.[287] A companion Air Force document, entitled *Counterspace Operations* discusses the "ways and means by which the Air Force achieves and maintains space superiority."[288] Offensive counterspace operations target an adversary's space systems and seek to "deceive, disrupt, deny, degrade, or destroy adversary space capabilities"—known as the "five D's."[289] To achieve these effects, it is not always necessary to target an adversary's satellite at all. It is often equally effective to attack an adversary's terrestrial system (the receiver) or the signal between the satellite and the receiver.[290]

2. National Space Policy

On 31 August 2006, U.S. President George W. Bush, issued a new national space policy (*2006 National Space Policy*),[291] replacing the 1996 national space policy (*1996 National Space Policy*).[292] Several provisions of both the old and new policies express

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[286] U.S., *Space Operations*, *supra* note 79 at 55 [emphasis added].

[287] The other three space mission areas include (1) space support; (2) space force enhancement; and (3) space force application. *Ibid.* at 4-5.

[288] U.S., *Counterspace Operations*, *supra* note 130 at 1.

[289] *Ibid.* at 2.

[290] *Ibid.* at 3.

[291] U.S., *2006 National Space Policy*, *supra* note 126.

[292] U.S., *U.S. National Space Policy*, Presidential Decision Directive-49 (14 September 1996)[U.S., *1996 National Space Policy*].

the U.S. intention to use ASATs in certain circumstances—though neither policy ever mentions the terms "anti-satellite weapon" or "ASAT."

The *2006 National Space Policy* reaffirmed the U.S.'s long-standing position that the peaceful use of outer space agreed to in the *Outer Space Treaty* includes military, though "non-aggressive," uses of space. Specifically it asserted, "'peaceful purposes' allow U.S. defense and intelligence-related activities in pursuit of *national* interests;"[293] More aggressively, it went on to note, "the United States will ... deny, if necessary, adversaries the use of space capabilities hostile to U.S. national interests."[294] On the same note of denying the use of space to adversaries, the *2006 National Space Policy* provided that the U.S. Secretary of Defense would, "[d]evelop capabilities, plans, and options to ensure freedom of action in space, and, if directed, *deny such freedom of action to adversaries*:"[295] Finally, the *2006 National Space Policy* mandated, "the Secretary of Defense shall: Maintain the capabilities to execute the space support, force enhancement, *space control*, and *force application* missions;"[296]

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[293] U.S., *2006 National Space Policy*, *supra* note 126 at 1 [emphasis added]. This is almost exactly the same language as used in the *1996 National Space Policy*, "'[p]eaceful purposes' allow defense and intelligence-related activities in pursuit of *national security and other goals*." U.S., *1996 National Space Policy*, *supra* note 292 at 1 [emphasis added].

[294] U.S., *2006 National Space Policy*, *supra* note 126 at 1-2. Again, this is almost no different than the *1996 National Space Policy*, which provided, "[n]ational security space activities shall contribute to U.S. national security by: ... (d) countering, if necessary, space systems and services used for hostile purposes;" U.S., *1996 National Space Policy*, *supra* note 292 at 3.

[295] U.S., *2006 National Space Policy*, *supra* note 126 at 4 [emphasis added]. This provision was also almost identical to President Clinton's *1996 National Space Policy*, which provided, "the United States will develop, operate, and maintain space control capabilities to ensure freedom of action in space and, if directed, *deny such freedom of action to adversaries*." U.S., *1996 National Space Policy*, *supra* note 292 at 4.

[296] U.S., *2006 National Space Policy*, *supra* note 126 at 4 [emphasis added]. Yet again, the *1996 National Space Policy* used almost identical language to say the exact same thing, "[the Department of Defense] shall maintain the capability to execute the mission areas of space support, force enhancement, space control, and force application." U.S., *1996 National Space Policy*, *supra* note 292 at 4.

Not surprisingly, the abrasive tone used throughout the *2006 National Space Policy* garnered much criticism.[297] This language comes across as offensive in light of the more diplomatic words used in the *Outer Space Treaty*—which used the word "peace" and "peaceful" eleven different times to describe the use of space. Other phrases that stand out strongly in the *Outer Space Treaty* include "international cooperation" and "mutual assistance." The *2006 National Space Policy* also uses the words "peaceful" and stresses that the U.S. "is committed to the exploration and use of outer space by all nations for peaceful purposes",[298] but unfortunately, this language gets lost amid the overall tone of the policy, which has been aptly described as "belligerent and bellicose, and reminiscent of a schoolyard bully."[299] Andrew Brookes, an aerospace analyst at the International Institute for Strategic Studies, noted, "[t]he language they [the U.S.] use is very belligerent in tone. The U.S. is seeking to dominate space, and this frightens others."[300] Viewed in context of the military doctrine—couched in terms of "space superiority," "dominance," "control," and "denial," it is no wonder that the rest of the world (and even U.S. citizens) finds the U.S. rhetoric offensive. As former U.S. Vice-President Al Gore commented, "[i]t is deeply disturbing that the administration so frequently uses the word *dominance* to describe it strategic goals."[301]

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[297] "Bush's space policy pursues hegemony in space and poses a significant security risk to China that cannot be left unaddressed." Bao Shixiu, "Deterrence Revisited: Outer Space" (Winter 2007) China Security 2, 2.

[298] U.S., *2006 National Space Policy*, *supra* note 126 at 1.

[299] Louis Friedman, "Belligerent Tone Mars U.S. Administration Space Policy" *The Planetary Society* (28 October 2006), online: The Planetary Society <http://www.planetary.org/about/executive_director/20061023.html> (accessed 29 May 2007).

[300] Mark Holmes, "MilSpace 2007: Military Forces Looking Forward Toward Space" *Satellite News* (12 March 2007).

[301] Al Gore, *The Assault on Reason* (New York: Penguin Press, 2007) at 158.

The fact is the *2006 National Space Policy* merely reiterated the *1996 National Space Policy*. It was less diplomatic, but it did not change a long-maintained U.S. policy, amounting to an assertion that it will defend its assets in space, and in the event of hostilities, may use force (ASATs) against enemy space assets.

3. Withdrawal from the 1972 Anti-Ballistic Missile Treaty

The withdrawal by the U.S. from the 1972 *Anti-Ballistic Missile Treaty* paved the way for the U.S. to develop a ballistic-missile defense program—including one in space if it so desires. The U.S. withdrawal from this agreement was the first withdrawal by any nation from an arms control agreement since World War II.[302]

4. Funding

No ASAT programs are specifically funded in the U.S. Defense Budget for FY 2008 (ending September 2008)—that is to say, no programs are listed as ASAT systems. That said, the USAF requested a total of $346.9 million for "Space Control" and "Counterspace Systems." Specifically, it requested $233.1 million for the operation and maintenance of its "Space Control Systems,"[303] $37.6 million for research and development of "Space Control Technology,"[304] $53.4 million for research and development of "Counterspace Systems,"[305] and $22.8 million for "Counterspace

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[302] Mark Bromley, "Implications of US Withdrawal from the ABM Treaty and Missile Defence" (Presentation delivered at Treaties Day School, King's College, London, 16 February 2002), online: British American Security Information Council <http://www.basicint.org/nuclear/NMD/MBpresentation-0202.htm> (accessed 29 May 2007).

[303] U.S., Department of Defense, *Operation and Maintenance Programs*, (February 2007) at 34, online: U.S. Department of Defense Defense Budget Materials: FY 2008 <http://www.defenselink.mil/comptroller/defbudget/fy2008/fy2008_o1.pdf> (accessed 25 June 2007).

[304] U.S., Department of Defense, *Research, Development, Test & Evaluation Programs*, (February 2007) at F-4, online: U.S. Department of Defense Defense Budget Materials: FY 2008 <http://www.defenselink.mil/comptroller/defbudget/fy2008/fy2008_r1.pdf> (accessed 25 June 2007).

[305] *Ibid.* at F-5.

System" procurement programs.[306] This combined expenditure of $346.9 million is a substantial amount and demonstrates the U.S. intent to continue to pursue ASAT development.

This amount does not include what is likely the most significant ASAT system of all—the $8.8 billion dollars requested for various programs tied to missile defense in FY 2008.[307] If any of this is for *space-based* BMD, the U.S. is engaged in the most extensive and expensive ASAT capability of all time.

5. Vote against PAROS Resolution

The General Assembly of the United Nations has passed a resolution entitled, "Prevention of an Arms Race in Outer Space" (PAROS) every year since 1981.[308] This resolution:

> Calls upon all States, in particular those with major space capabilities, to contribute actively to the objective of the peaceful use of outer space and of the prevention of an arms race in outer space and to refrain from actions contrary to that objective and to the relevant existing treaties in the interest of maintaining international peace and security and promoting international cooperation;[309]

The United States was the sole nation to vote *against* this resolution, which, in 2006, passed by a vote of 178-1-1 (Israel was the one abstention).[310] Incidentally, the

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[306] U.S., Department of Defense, *Procurement Programs*, (February 2007) at F-20, online: U.S. Department of Defense Defense Budget Materials: FY 2008 <http://www.defenselink.mil/comptroller/defbudget/fy2008/fy2008_p1.pdf> (accessed 25 June 2007).

[307] U.S., *Costs by Weapon System*, *supra* note 37 at iii.

[308] "Index of Online General Assembly Resolutions Relating to Outer Space: Recorded Votes on Resolutions," online: United Nations Office for Outer Space Affairs <http://www.unoosa.org/oosa/SpaceLaw/gares/gavotes.html#ARES_61_111> ["GA Resolution Votes"] (accessed 9 July 2007).

[309] *Prevention of an arms race in outer space*, GA Res. 61/51, UN GAOR, 61st Sess., UN Doc. A/Res/61/58 (2006) at para. 4.

[310] Israel abstained from the vote, all other nations voted for the resolution, with the exception of 13 minor nations that were absent. "GA Resolution Votes", *supra* note 308.

U.S. only voted against PAROS in 2005 and 2006.[311] In all prior years from 1981 through 2004, the U.S. had abstained from the vote.[312] PAROS, as a General Assembly resolution, does not bind (or legally obligate in any way) either the U.S. or even the States that voted in its favor.[313] Nevertheless, the recent U.S. vote against PAROS reflects a U.S. position that is steering towards increased militarization of outer space, most notably through a space-based missile defense program, but potentially also signaling an increased willingness to use ASATs.[314] As noted in the *Space Commission Report* after commenting on the yearly General Assembly PAROS resolution, "[t]he U.S. should seek to preserve the space weapons regime established by the Outer Space Treaty, particularly the traditional interpretation of the Treaty's 'peaceful purposes' language to mean that both self-defense and non-aggressive military use of space are allowed."[315]

In February 2007, U.S. Ambassador Christina Rocca told the U.N. Conference on Disarmament that the arms race in space "does not exist."[316] She noted the difficulties encountered during prior attempts at ASAT arms control in defining "space weapon" and noted, "What is often meant is whatever the U.S. may be exploring in terms of ballistic

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[311] *Ibid.*

[312] *Ibid.*

[313] *Charter of the United Nations*, art. 10 (noting "[t]he General Assembly ... may make recommendations." See also Ian Brownlie, *Principles of Public International Law* (Oxford: Oxford University Press, 2003) 663 n.82 (noting "resolutions ... are recommendations creating prima facie no legal obligations").

[314] Rebecca Johnson, "Enhanced Participation and Politicking: Report on the 2005 UN First Committee" (Winter 2005) 81 *Disarmament Diplomacy*, online: The Acronym Institute <http://www.acronym.org.uk/dd/dd81/81unfc.htm> (accessed 24 June 2007).

[315] U.S., *Space Commission Report*, *supra* note 151 at 37.

[316] UN Conference on Disarmament, "Statement to the Conference on Disarmament by Ambassador Christina Rocca, U.S. Permanent Representative: Prevention of an Arms Race in Outer Space" (13 February 2007), online: Reaching Critical Will <http://www.reachingcriticalwill.org/political/cd/speeches07/1session/feb13USA.pdf> (accessed 28 June 2007) ["Statement of Ambassador Rocca on PAROS"].

missile defenses in space, but not weapons on the ground that would attack satellites in space."[317] This highlights that perhaps most of the U.S. reluctance to PAROS is indicative of its planned missile defense—which will, as previously discussed, be a particularly effective ASAT, and also be partly based in space.

The U.S. intent to use ASATs is clear when you consider the combination of its military doctrine, national space policy, funding for "Space Control," "Counterspace Systems," and BMD and also its recent withdrawal from the 1972 *Anti-Ballistic Missile Treaty* and the U.S. vote against PAROS. With U.S. ASAT intentions established, it's time to review those of other States, most notably, China's intentions to use ASATs.

B. Chinese Intentions to Use ASAT Weapons

1. Declared Intention not to Use ASATs

China's words and actions conflict with each other over its future intentions to use ASATs. On the one hand, China has long sought for an international agreement to prohibit using ASATs. In 2002, China joined with Russia in presenting a draft international agreement to the United Nations Conference on Disarmament that would prevent the deployment of weapons in space and also prevent the threat or use of force against space objects.[318] This proposal notes, "[f]or the benefit of mankind, outer space shall be used for peaceful purposes, and it shall never be allowed to become a sphere of

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[317] *Ibid.* at 2.

[318] *Letter Dated 27 June 2002 from the permanent representative of the People's Republic of China and the permanent representative of the Russian Federation to the Conference on Disarmament addressed to the Secretary-General of the conference transmitting the Chinese, English and Russian texts of a working paper entitled "Possible Elements for a Future International Legal Agreement on the Prevention and Use of Force Against Outer Space Objects*, UN Doc. CD 1679 (28 June 2002) [*Proposed Chinese/Russian Space Weapons & ASAT Treaty*].

military confrontation."[319] The proposed treaty would obligate States "[n]ot to place in orbit around the Earth any objects carrying *any kinds* of weapons" and prevents the stationing of weapons of any kind on celestial bodies or anywhere in space.[320] Regarding ASAT use, the agreement merely provides that States may not "resort to the threat or use of force against outer space objects."[321] Of course, this all seems rather redundant to Article 2(4) of the U.N. Charter, which already prohibits the threat and use of force. The only new provision of the proposed agreement is the part that expands the prohibition of weapons in space to "any kinds of weapons."

Another verbal indication from China that it was against ASAT use was its corollary to the *2006 National Space Policy*. Only days after the U.S. issued the *2006 National Space Policy*, China released a document entitled, "China's Space Activities in 2006."[322] China's policy mentioned absolutely nothing about their military space programs—in stark contrast to the U.S.'s *2006 National Space Policy*, which as previously discussed, sounded warlike. As noted by the U.S. Department of Defense, China's space policy "remains silent on the military applications of China's space programs and counter space activities."[323]

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[319] *Ibid.* art. II.

[320] *Ibid.* art. III [emphasis added].

[321] *Ibid.* art. III.

[322] China, White Paper, *supra* note 128.

[323] U.S., *2007 Report on China's Military Power*, *supra* note 127 at 1.

Even following its recent ASAT test on 11 January 2007, China's Foreign Ministry spokesman Liu Jianchao noted China was still committed to the "peaceful development of outer space."[324]

2. ASAT Test & Military Modernization

China's actions, however, do not resemble its verbal commitment to the peaceful use of outer space and its desire for an international agreement banning the use of ASATs. China, says, "let's agree not to use ASATs," but its recent ASAT test in January of 2007 was the first use of an ASAT in space in over 20 years (since the U.S.'s ALMV ASAT in 1985).

Also, China has recently undertaken an extensive effort to modernize its military. China claims its military budget for 2007 is approximately $45 billion,[325] twice what it claimed it had budgeted for its military in 2003 ($22.3 billion).[326] The U.S. estimates, however, that China is spending substantially more—between $85 to $125 billion in 2007.[327] China's military modernization includes a variety of missiles that have precision-strike capability (involving missiles of all ranges and launched from the air, land and sea),[328] a variety of ASAT programs (discussed earlier), cyber-space warfare capabilities, advanced mines, submarines, and fighter aircraft.[329]

3. Preparations for Attack on Taiwan or Elsewhere

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[324] "China confirms satellite downed" *BBC News* (23 January 2007), online: BBC News <http://news.bbc.co.uk/2/hi/asia-pacific/6289519.stm> (accessed 14 June 2007).

[325] U.S., *2007 Report on China's Military Power*, *supra* note 127 at 25.

[326] *Ibid.* at 26.

[327] *Ibid.* at 25.

[328] *Ibid.* at 17.

[329] *Ibid.*

When viewed in the context of China's recent military modernization program, the Chinese ASAT test may be an indication of Chinese preparations for an attack on Taiwan. "China's space activities and capabilities, including anti-satellite programs, have significant implications for anti-access/area denial in Taiwan Strait contingencies and beyond."[330] Defense Department consultant, Michael Pillsbury, warns that over the past six years, three Chinese Army Colonels have written books advocating the use of ASAT weapons against U.S. satellites as part of a surprise attack:

> What they are doing in their books is saying that if China faces a hostile United States in the future, we Chinese may need to have some way to deter the United States from either attacking us, or coming to the defense of Taiwan. If we Chinese ever face that situation, one good way to deter the United States—they use the term 'bring America to its knees'—is to have a 'shock attack,' or a 'shock and awe' attack to borrow a term we [Americans] used during the 2003 invasion of Iraq, on U.S.-based satellites.[331]

Another report to the U.S. Congress noted that Chinese "officials and scholars have been warning that 2007 is a critical year with potential crises in the Taiwan Strait, citing their concerns about perceived pro-independence moves by Taiwan's president."[332] That said, U.S. intelligence estimates indicate that it will take China until the end of the decade to prepare its modern force to defeat a moderate-sized adversary.[333]

Another recent indication that China is preparing for a future conflict with the U.S. (or warning it to stay out a conflict over Taiwan) is the surfacing of a Chinese attack

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[330] *Ibid.* at 20.

[331] Deborah Tate, "Defense Expert Issues Warning on China's Anti-Satellite Efforts" *Voice of America News* (30 March 2007) online: Voice of America < http://www.voanews.com/english/archive/2007-03/2007-03-30-voa71.cfm?CFID=162298751&CFTOKEN=56324449> (accessed 14 June 2007).

[332] Shirley Kan, "China's Anti-Satellite Weapon Test" *Congressional Research Service Report for Congress* (RS22652) (23 April 2007).

[333] U.S., *2007 Report on China's Military Power*, *supra* note 127 at 15.

submarine within firing distance of a U.S. carrier battle group.[334] On 26 October 2006, a Chinese submarine, equipped with Russian-made wake-homing torpedoes and anti-ship cruise missiles, shadowed a U.S. carrier and surfaced within five miles—within firing range of its torpedoes and missiles.[335]

China's military modernization is geared towards "prosecuting a range of military operations in Asia—well beyond Taiwan."[336] Hence, it is possible that China is preparing for conflict much farther away than Taiwan.

The possibilities for potential attacks include one against a current ally—Russia. In October of 2006, China conducted a 10-day troop exercise in a couple of military districts bordering Russia. The exercises were characterized as "in depth offensive operations in mountainous areas and on the plains" and were viewed as preparations for an offensive war against Russia or Kazakhstan.[337] China's ASAT test in January 2007 could be a warning to Russia as well as to the U.S., as Russia also has a large number of space assets. That said, Russia and China have extensive military connections. In fact, Russia and China plan on conducting eight cooperative military activities in 2007.[338] Russia is also China's primary provider of military assets "selling it advanced fighter aircraft, missile systems, submarines, and destroyers."[339]

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[334] Bill Gertz, "China sub stalked U.S. fleet" *The Washington Times* (13 November 2006), online: The Washington Times <http://washingtontimes.com/national/20061113-121539-3317r.htm> (accessed 14 June 2007).

[335] *Ibid.*

[336] U.S., *2007 Report on China's Military Power*, *supra* note 127 at 22.

[337] Litovkin, *supra* note 186 at 5.

[338] U.S., *2007 Report on China's Military Power*, *supra* note 127 at 1.

[339] *Ibid.* at 28.

The Assembly of the Western European Union recently characterized Russia and China as "cultivating a close relationship" and having an "alliance of convenience."[340] Following the recent Chinese ASAT test, rather than condemning China, Russia first questioned the reliability of U.S. intelligence on the ASAT, and then blamed the U.S. plans for space weapons as the reason for the test.[341]

C. Russian Intentions to Use ASAT Weapons

1. Proposals to Ban All Space Weaponry

In 1978 and 1979, the USSR and the U.S. made several attempts to negotiate an international agreement limiting ASATs.[342] Discussions included the possibility of a complete prohibition of all ASAT weapons (first proposed by U.S. negotiators), a moratorium on the testing of ASATs and alternatively a "noninterference" agreement and the creation of "rules of the road" (e.g., an agreement to stay a certain distance from each other's satellites).[343] The USSR also expressed concerns with the potential use of the U.S. Space Shuttle as an ASAT.[344] The USSR was willing to discuss a moratorium on testing, but not the dismantling of their current co-orbital ASATs (which would have left the USSR with the only operational ASAT system).[345] One proposal by the USSR also

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[340] Assembly of Western European Union, "Weapons in Space: Part II", Document 1966, para. 46, 53rd session, 6 June 2007.

[341] Theresa Hitchens, "U.S.-Sino Relations in Space: From 'War of Words' to Cold War in Space?" (Winter 2007) *China Security* 12 at 21, online: Space Debate.org <http://www.wsichina.org/%5Ccs5_2.pdf> (accessed 26 June 2007).

[342] Stares, *supra* note 49 at 196.

[343] *Ibid.* at 197.

[344] *Ibid.*

[345] *Ibid.*

sought only to restrict the use of ASATs against each other's satellites.[346] ASAT negotiations came to an end, however, when the USSR invaded Afghanistan in December 1979.[347]

In August 1981, the USSR presented the United Nations General Assembly a proposed "Draft Treaty on the Prohibition of the Stationing of Weapons of Any Kind in Outer Space."[348] This proposed treaty prevented the stationing in orbit of "weapons of any kind" but included a provision that was seen as allowing the use of ASATs against a space object that was carrying a weapon of any kind.[349] This was especially problematic as "weapon" was not defined in the proposal—leaving open such basic questions as whether the self-destruct apparatus on the Space Shuttle made it a weapon or if satellites that were part of a "weapon system" were weapons, even though they were not the part of the system that deployed the munitions.[350] The proposal also did not ban the testing or development of ASATs, just their use against the satellites of other States that did not carry weapons.[351] Rebecca Strode concluded that the USSR's proposed treaty was not an attempt to preclude ASAT warfare, but rather "suggests that the Soviet Union is committed to refining its own ASAT systems and is incorporating offensive ASAT operations into its overall strategic doctrine."[352]

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[346] *Ibid.* at 198.

[347] *Ibid.* at 199.

[348] Rebecca V. Stode, "Commentary on the Soviet Draft Space Treaty of 1981" in Colin S. Gray, *American Military Space Policy: Information Systems, Weapon Systems and Arms Control* (Cambridge, MA: Abt Books, 1982) at 85.

[349] *Ibid.* at 85, 88, and 116.

[350] *Ibid.* at 87.

[351] *Ibid.* at 116.

[352] *Ibid.* at 90.

2. Moratorium

Some would cite the USSR's 1983 moratorium on testing ASATs as evidence of its derision against ASAT use. Specifically, in 1983, just after it completed testing its co-orbital ASAT system the President of the USSR announced that the USSR would impose a "moratorium on such launching for the entire period during which other countries, including the United States, will refrain from stationing in outer space anti-satellite systems of any type."[353] Notably, however, this announcement also came just after U.S. President, Ronald Reagan, had announced the "Star Wars" BMD program and also right before the U.S. was to begin testing of its ALMV ASAT.[354] Hence, though the announcement of a moratorium on ASAT testing may have looked like Soviet commitment to protecting the sanctuary of space, the moratorium was likely an attempt to maintain the Soviet advantage by stifling the U.S. attempt at parity.[355]

Ulterior motives aside, the moratorium, as a "unilateral declaration," legally bound Russia to its terms. In the *Nuclear Tests* case, the International Court of Justice held that the declarations by French governmental officials, including the French President and Foreign Minister, announcing that France had finished atmospheric nuclear testing bound it to stop conducting nuclear tests in the atmosphere.[356] The court noted, "interested States may take cognizance of unilateral declarations and place confidence in

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[353] Laura Grego, "A History of Anti-Satellite Weapons Programs" n. 11, online: Union of Concerned Scientists <http://www.ucsusa.org/global_security/space_weapons/a-history-of-asat-programs.html> (accessed 28 June 2007). See, U.S., *Policy on ASAT Arms Control*, *supra* note 213 at 13.

[354] Grego, *supra* note 353.

[355] U.S., *Policy on ASAT Arms Control*, *supra* note 213 at 14.

[356] *Nuclear Tests Case* (Australia v. France), [1974] I.C.J. Rep. 253 at 269.

them, and are entitled to require that the obligation thus created be respected."[357] Likewise, the USSR's moratorium, though only a "unilateral declaration" is binding on Russia, and may be relied on by other States.

3. Proposed Treaty in 2002

Though all of the above actions by Russia (or the former USSR) might be viewed with skepticism, the treaty it jointly proposed with China to the U.N. Conference of Disarmament in 2002[358] seems substantially more sincere. If nothing else, it demonstrates Russia's willingness to return to the negotiating table in an attempt to find a satisfactory solution to the problem of ASATs. Perhaps this treaty is, like the earlier moratorium, a response to plans for a U.S. missile defense system that plans, in part, to have space-based defenses. This proposed treaty, unlike the one Russia proposed in 1981, completely bans the threat or use of ASATs (though once again, it leaves open their testing and development).[359]

Russian officials have also pledged that they would not be the first to station ASATs in space.[360] Russia has not conducted an ASAT test since 1982 when it completed testing its co-orbital ASAT system. This restraint, viewed in concert with its efforts since 1981 to partially limit the use of ASATs is certainly not indicative that Russia is involved in a space weapons race. That said, Russia has not remained silent on the effects of such a race.

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[357] *Ibid.* at 268.

[358] *Proposed Chinese/Russian Space Weapons & ASAT Treaty*, *supra* note 318.

[359] *Ibid*, art. III.

[360] U.S., *Policy on ASAT Arms Control*, *supra* note 213 at 14. This pledge was repeated in 2007. "Assembly urges common stance on weapons in space" (6 June 2007), online: Assembly of the WEU <http://www.assembly-weu.org/en/presse/ep/2007/27-2007.php> (accessed 28 June 2007).

4. Russia's Reaction to U.S. BMD

The U.S. BMD program has caused considerable consternation in Russia. In February 2007, Russian President Putin, warned:

> [I]t is impossible to sanction the appearance of new, destabilizing high-tech weapons. Needless to say, this refers to measures to prevent new areas of confrontation, especially in outer space .... In Russia's opinion, the militarization of outer space could have predictable consequences for the international community, and provoke nothing less than the beginning of a nuclear era.[361]

Recently, U.S. plans to build BMD facilities in Poland and the Czech Republic brought threats from Russia that it would point its missiles at Europe.[362] More than rhetoric, Russia has been developing ballistic missiles that it touts as able to penetrate ballistic missile defense systems. In May 2007, Russia announced a successful test of the RS-24—an intercontinental ballistic missile with multiple warheads.[363] In June 2007, Russia successfully tested a sea-based intercontinental ballistic missile that had up to 10 warheads each capable of attacking separate targets.[364] Russia boasts that both missiles can penetrate BMD systems.[365]

Even though Russia has not visibly taken part in an ASAT race for some time, it has been clear on its positions against both U.S. weapons in space and also U.S. plans for BMD. Russia is not a State that should be ignored.

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[361] UN Conference on Disarmament, "Statement to the Conference on Disarmament by Ambassador Valery Loshchinin" (13 February 2007), online: Reaching Critical Will <http://www.reachingcriticalwill.org/political/cd/speeches07/1session/feb13Russia.pdf> [*Statement of Russian Ambassador on PAROS*] (accessed 28 June 2007) (quoting Russian President Vladimir Putin).

[362] Bronwen Maddox, "US wrong on arms control treaties" *The Dominion Post* (4 July 2007) B5.

[363] "Russia Tests Missile: Successful launch from nuclear submarine" *The Montreal Gazette* (29 July 2007) A19.

[364] *Ibid.*

[365] *Ibid.*

D. Intentions of Terrorists to Use ASATs

There have been no terrorist attacks against space assets to date. That said, back in 2001, the U.S. Space Commission recognized the potential for terrorists to threaten vulnerable U.S. space systems.[366] The concern remains valid today as noted in a report submitted to the Assembly of the Western European Union, "[s]ome sufficiently highly motivated mafia or terrorist cells have enough financial resources to do real damage to a state's space capability."[367]

U.S. Senator Jon Kyl warned of how easy it would be for al Qaeda to launch a nuclear warhead into the atmosphere from one of the eighty or so freighters it owns.[368] Such an attack would, no doubt, cause much more damage today than project STARFISH Prime caused back in 1962—both to the electronic infrastructure on the ground and to satellites in Low Earth Orbit (which by far outnumber the satellites in Low Earth Orbit back in 1962).[369]

The fear of terrorist use of either ballistic missiles or ASATs is in large part the reasoning behind the lack of confidence in an anti-ballistic missile treaty. A terrorist organization is not likely to be deterred by "mutually assured destruction." If you can't deter them, you need to be able to stop them.

The use of ASATs by terrorists seems far less likely than use by the U.S., China or Russia. All of these States have demonstrated substantial ability and indicated

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[366] U.S., *Space Commission Report*, *supra* note 151 at 24.

[367] Assembly of Western European Union, "Weapons in Space: Part II", Document 1966, para. 100, 53rd session, 6 June 2007.

[368] Independent Working Group, *supra* note 134 at 10.

[369] *Ibid.* at 9.

dangerous intent. This being the case, the next Chapter of this thesis will discuss the various legal implications of the use of ASATs. The Chapter will begin with an analysis of the laws relating to the use of force in general, including the right of self-defense, then progress through relevant provisions of the laws of armed conflict. Then it will address the implications of the weaponization of outer space and end with a discussion of efforts at non-proliferation that relate to outer space activities.

Chapter Four: War in Space

A. The Use of Force is Illegal except in Self-Defense or as Authorized by the Security Council

1. Outlawing Both the Use and the Threat of Using Force

Following World War I international treaties were adopted that outlawed war.[370] Both the *Covenant of the League of Nations*[371] (never ratified by the U.S.) and the *Kellogg-Briand Pact* of 1928[372] (still in effect) outlawed war. Though these treaties did not prevent Japan from invading Manchuria in 1931, Italy from invading Abyssinia in 1935 or Germany from invading Poland in 1939,[373] they did, however, firmly establish in international law that the threat of or use of force against another nation was unlawful. For violations of this legal principle, many of the instigators of World War II were

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[370] Customary international law, even prior to WWI already prohibited war and provided for the exception of self-defense. Yoram Dinstein, *War Aggression and Self-Defence*, 4th ed. (Cambridge: Cambridge University Press, 2005) at 181-82.

[371] *Covenant of the League of Nations* [*Treaty of Versailles*], 28 June 1919, 2 Bevans 43. Several provisions of the *Covenant of the League of Nations* respect the prevention of war. Most notably, the preamble provides, that the purpose of the treaty was to "promote international co-operation and to achieve international peace and security by the acceptance of obligations not to resort to war ...." Also "[t]he Members of the League undertake to respect and preserve as against external aggression the territorial integrity and existing political independence of all Members of the League." Art. X.

[372] "The High Contracting Parties solemly declare in the names of their respective peoples that they condemn recourse to war for the solution of international controversies, and renounce it, as an instrument of national policy in their relations with one another." *Renunciation of War as an Instrument of National Policy (Kellogg-Briand Peace Pact)*, 27 August 1928, 2 Bevans 732, art. 1 (the 15 original signing parties included the following States: Germany, the U.S., Belgium, France, the U.K., Canada, Australia, New Zealand, South Africa, Ireland, India, Italy, Japan, Poland and Czechoslovakia). Numerous other States later adhered to the Kellogg-Briand Pact, including both China and Russia. "Kellogg-Briand Pact of 1928" online: The Avalon Project <http:www.yale.edu/lawweb/avalon/kbpact/kbpact.htm> (accessed 4 July 2007).

[373] J.A.S. Grenville, *A History of the World: From the 20th to the 21st Century* (Oxon: Routledge, 2005) at 195, 211 and 238.

prosecuted for the "crime against peace" (i.e., waging a war of aggression) at the Nuremberg Tribunal[374] and the International Military Tribunals at Tokyo.[375]

Following World War II, the victor nations once again tried to firmly abolish war. Article 2(4) of the Charter of the United Nations bans the use of force, or even the threat of using force in international relations. Specifically, it provides, "[a]ll Members shall refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any state, or in any other manner inconsistent with the Purposes of the United Nations."

2. The Right of Self-Defense

After banning the use of or even the threat of using force, the Charter acknowledges that States can legally defend themselves. Specifically, Article 51 provides, in pertinent part, "[n]othing in the present Charter shall impair the inherent right of individual or collective self-defence *if an armed attack occurs* against a Member of the United Nations, *until the Security Council has taken measures necessary* to maintain international peace and security." (Emphasis added).

The U.N. Charter does not give permission for States to use force in self-defense, it acknowledges what it calls an "inherent right." The Charter merely recognizes the right of self-defense, collective and individual. That said, the Charter qualifies the right of self-defense in the very same sentence that recognizes this exception to the general prohibition on the use of force or the threat of using force. Self-defense is permitted "if

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[374] James Owen, *Nuremberg: Evil on Trial* (London: Headline Review, 2006) at 6.

[375] Brownlie, *supra* note 313 at 559.

an armed attack occurs" and even then, only "until the Security Council has taken measures necessary to maintain international peace and security."

Applying this law to the current subject matter, the general rule is that it is illegal to attack another country's satellites with an ASAT. The exception to this general rule allows targeting a satellite of an adversary if the attack is pursuant to self-defense or with authorization from the Security Council.

Some have argued that "self-defense" is a broad term that includes not only a response to armed attack, but also what is known as "preemptive" or "anticipatory" self-defense.[376] The U.S. holds such a view. The National Security Strategy of the U.S. plainly states, "the United States will, if necessary, act preemptively."[377] Furthermore, the U.S. maintains the right of anticipatory self-defense "even if uncertainty remains as to the time and place of the enemy's attack."[378] It notes, however, "[t]he United States will not use force *in all cases* to preempt emerging threats, nor should nations use preemption as a pretext for aggression."[379] The use of the words, "in all cases" highlights the intent of the U.S. to, in some cases, use force to prempt "emerging threats." The U.S. position, however, is that anticipatory and preemptive self-defense is in keeping with Article 51 of the U.N. Charter. "[B]y specifically extending the principles of the U.N. Charter to

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[376] "There was no intention at San Francisco to change the existing law, which included anticipatory self-defence *in the face of imminent attack*." Michael C. Wood, "Towards New Circumstances in Which the Use of Force May be Authorized? The Cases of Humanitarian Intervention, Counter-Terrorism, and Weapons of Mass Destruction" in Niels Blokker & Nico Schrijver, eds., *The Security Council and the Use of Force: Theory and Reality—A Need for Change?* (Leiden: Martinus Nijhoff, 2005) 75 at 80 [emphasis added].

[377] U.S., *The National Security Strategy of the United States of America*, White House, Washington, September 2002, 15, online: The White House <http://www.whitehouse.gov/nsc/nss.html> (accessed 27 June 2007).

[378] *Ibid.*

[379] *Ibid.*

space, the Outer Space Treaty (Article III) provides for the right of individual and collective self-defense, including 'anticipatory self-defense.'"[380]

With this interpretation, frankly, the UN Charter's prohibition on the use of force does very little to restrict the use of ASATs. Oddly, defenders of the position that self-defense includes preemptive or anticipatory attacks frequently refer to the 1837 *Caroline Case*. The *Caroline Case* dealt with the British destruction of U.S. ship in U.S. waters that was assisting an armed rebellion in Canada.[381] In this case, Daniel Webster, then Secretary of State, recognized that self-defense could include preemption. But for such an attack to truly be self-defense, he noted, "[t]here must be a necessity of self-defence, instant, overwhelming, leaving no choice of means and no moment for deliberation."[382] The current U.S. position is far more forward-leaning in its application of anticipatory self-defense than Mr. Webster's enunciation of the concept. Furthermore, it has been pointed out that there was nothing anticipatory about the *Caroline Case*. The ship had already been used for transporting men and materials in support of the anti-British rebellion in Canada.[383]

Judge Schwebel of the International Court of Justice also argued that preemptive attacks were permissible under Article 51 of the U.N. Charter. He noted in his dissent in the *Military and Paramilitary Activities Case*, "I do not agree with a construction of the United Nations Charter which would read Article 51 as if it were worded: 'Nothing in the

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[380] U.S., *Space Commission Report*, *supra* note 151 at 37.

[381] *Caroline Case* (1837) 2 Moore 409.

[382] *Ibid.*

[383] Dinstein, *supra* note 370 at 184-85.

present Charter shall impair the inherent right of individual or collective self-defence *if, and only if*, an armed attack occurs ...'"[384]

To read Article 51 in this light, however, would render a major portion of Article 51 superfluous. It would have been simple enough for the drafters to end the sentence after the word "self-defence" if that was their intention. Following basic principles of treaty interpretation, one cannot focus on the first 15 words of a sentence and then reject the final 26 words of the exact same sentence. The words of a treaty must be "interpreted in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context [not in disregard of over half of the text] and in light of its object and purpose."[385] Furthermore, no where in Article 51 or elsewhere in the U.N Charter is there any indication that self-defense can be exercised in anticipation of an attack. The majority ruling in the International Court of Justice's *Military and Paramilitary Activities Case* also ruled against preemptive or anticipatory self-defense. The Court held that "States do not have a right of 'collective' armed response to acts which do not constitute

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[384] *Military and Paramilitary Activities* (Nicar. v. U.S.), 1986 I.C.J. 4 (June 27) at 347 (the actual issue in the case was not whether self-defense could be "anticipatory" but whether the U.S. was properly exercising "collective self-defense." The majority held that the U.S. was not engaged in collective self-defense when it conducted military and paramilitary activities in support of the contras against the Nicaraguan government) [*Military and Paramilitary Activities*].

[385] *Vienna Convention on the Law of Treaties*, 23 May 1969, 1155 U.N.T.S. 331 at 340, art. 31(1). "Since the fundamental provisions of the Vienna Convention codify the customary international law of treaties, the Convention is, in principle, applicable even for States that have not ratified it." Paul S. Dempsey & Michael Milde, *International Air Carrier Liability: The Montreal Convention of 1999*, (Montreal: McGill University, 2005) at 45. U.S. courts have also quoted the *Vienna Convention* as binding on them as customary international law. See *Chubb & Son v. Asiana Airlines*, 214 F.3d 301 at 304 (2d Cir. 2000), *cert. denied* 533 U.S. 928 (2001). Hence, the *Vienna Convention* applies to the U.S., as customary international law, even though the U.S. has not ratified it.

an 'armed attack.'"[386] On the same lines, the court noted, "the right of collective self-defense presupposes that an armed attack has occurred."[387]

The conclusion of the majority of legal scholars is that Article 51 does not permit preemptive or anticipatory self-defense.[388] As Professor Ian Brownlie plainly put it, "[t]his doctrine lacks a legal basis."[389]

B. The Laws of Armed Conflict Apply to the Use of ASATs

Contrary to the adage, "all is fair in love and war," there is a large body of laws governing warfare. Laws governing warfare are not a new phenomenon; Egypt concluded agreements covering the treatment of prisoners of war as early as 1400 B.C. and India prohibited the use of poisonous weapons as early as 500 B.C.[390] The Bible also contains laws of warfare, notably, "[a]s you approach a town to attack it, you must first offer its people terms for peace."[391]

Modern laws of warfare, now collectively referred to as the Laws of Armed Conflict (LOAC), stem from a combination of customary international law, along with numerous treaties—most notably, the Hague Conventions of 1907 (limiting the methods of warfare) and the Geneva Conventions of 1949 (providing protection for victims of warfare).[392] LOAC limits when a State can wage war, the weapons it may use, the targets

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[386] *Military and Paramilitary Activities*, *supra* note 384 at 100.

[387] *Ibid.* at 110.

[388] Dinstein, *supra* note 370 at 185.

[389] Brownlie, *supra* note 313 at 702.

[390] Ingrid Detter, *The Law of War*, 2d ed. (Cambridge: Cambridge University Press, 2000) at 151.

[391] *Deuteronomy* 20:10 (New Living Translation).

[392] W. Michael Reisman and Chris T. Antoniou, eds., *The Laws of War: A Comprehensive Collection of Primary Documents of International Laws Governing Armed Conflict* (New York: Vintage Books, 1994).

a State may attack and also provides a variety of humanitarian rules to limit unnecessary suffering caused by war.[393] LOAC is commonly divided into three principles—military necessity (only targeting objects that will give a distinct military advantage), proportionality (balancing anticipated military advantage against harm caused) and chivalry (reducing suffering caused by war).

1. Applying LOAC to Outer Space

Article III of the *Outer Space Treaty* provides:

> States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the Moon and other celestial bodies, *in accordance with international law*, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international cooperation and understanding.[394]

Hence, the authors of the *Outer Space Treaty* reaffirmed the duty States have to comply with existing international law—even in regard to activities in outer space. Not only does LOAC apply to activities in space, it applies at all times—in peace and also during times of war. As Professor Ian Brownlie noted in his seminal book on public international law: "[m]any treaties, including the Charter of the United Nations, are intended to be no less binding in case of war, and multipartite law-making agreements such as the Geneva Conventions of 1949 survive war or armed conflict."[395] LOAC applies in all places (including space) and at all times and hence, for present purposes it is important to consider the LOAC implications of using ASATs against satellites belonging to other nations.

2. Targeting Civilian Satellites

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[393] Detter, *supra* note 390 at 159.

[394] *Outer Space Treaty*, *supra* note 48, art. III [emphasis added].

[395] Brownlie, *supra* note 313 at 592.

Protocol I of the Geneva Conventions of 1949 provides the basic rule regarding protecting civilian "objects" from attack:

> In order to ensure respect for and protection of the civilian population and civilian objects, the Parties to the conflict shall at all times distinguish between the civilian population and combatants and between civilian objects and military objectives and accordingly shall direct their operations only against military objectives.[396]

"[C]onstant care" was to be taken to spare "civilian objects."[397] Civilian objects, are defined as "all objects which are not military objectives".[398] Military objectives are then defined as "those objects which by their nature, location, purpose or use make an effective contribution to military action and whose total or partial destruction, capture or neutralization, in the circumstances ruling at the time, offers a definite military advantage."[399]

The difficulty with satellites, however, is that almost all civilian satellites could be used for a military purpose. Michel Bourbonnière, legal counsel for the Canadian Space Agency, noted that communications, navigational and remote-sensing satellites could be considered as military targets because of their use by the military.[400] After subtracting these satellites from those that might be protected as "civilian objects," there are not many remaining. Michel Bourbonnière posited that meteorological satellites would be

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[396] *Protocol Additional to the Geneva Conventions of 1949, and Relating to the Protection of Victims of International Armed Conflicts (Protocol I)*, 8 June 1977, 1125 U.N.T.S. 3, art. 48 [emphasis added] [*Protocol I*].

[397] Ibid., art. 57(1).

[398] *Ibid.*, art. 52(1).

[399] *Ibid.*, art. 52(2).

[400] Michel Bourbonnière, "National-Security Law in Outer Space: The Interface of Exploration and Security" (Winter 2005) 70:1 J. Air L. & Com. 3 at 50.

"more dubious" as a military target than these others,[401] but in light of the importance to modern militaries of meteorological satellites, as discussed previously, they are arguably just as much a military target as the ones Mr. Bourbonnière mentioned. This provision may, however, provide some limited legal protection to satellites engaged in solely scientific research, for example, satellites studying solar physics.

3. Protection of "Buildings" Dedicated to Science / Historic Monuments

The Hague Conventions may provide some protection to satellites that are "dedicated" to science, or that may be regarded as historic monuments. Specifically "[i]n sieges and bombardments all necessary steps must be taken to spare, as far as possible, *buildings* dedicated to religion, art, science, or charitable purposes, historic monuments, hospitals, and places where the sick and wounded are collected, provided they are not being used at the time for military purposes."[402] For this Hague Convention provision to apply to satellites, a satellite would have to be equated to a "building," as protected by the text of the Convention. This comparison is easier to make when you are talking about manned space stations, like the Mir or the International Space Station—essentially, buildings in space. It is also arguable that the International Space Station has reached the status of being a "historic monument" and entitled to protection on that ground as well.[403] That said, though the International Space Station is a "permanently inhabited civil

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[401] *Ibid.*

[402] *Hague Convention (IV) Respecting the Laws and Customs of War on Land*, 18 October 1907, (1908 Supp.) 2 AM. J. INT'L L. 90, art. 27 (entered into force Jan. 26, 1910) [*Hague Convention (IV)*].

[403] Cultural property includes "movable or immovable property of great importance to the cultural heritage of every people ...." *Convention for the Protection of Cultural Property in the Event of Armed Conflict*, 14 May 1954, 249 U.N.T.S. 215, art. 1(1)(a).

international Space Station for peaceful purposes",[404] the U.S. has persistently interpreted the word "peaceful" as meaning "non-aggressive" as opposed to "non-military." In light of the U.S. interpretation of "peaceful," the International Space Station, if used for military purposes (e.g., it's in a great orbit to conduct surveillance), may be a valid military target on those grounds.

4. Use of or Damage to Satellites Belonging to Neutral Powers

A "neutral" State is any State that is not participating in a conflict as one of the belligerent States—it is an "impartial" State.[405] The basic principle underlying neutrality "requires neutrals not to intervene directly or indirectly in a war and requires belligerents to abstain from involving them."[406] The territories of "neutral" States are "inviolable," so belligerent States cannot attack these territories.[407] Though space is not the "territory" of any State, but is, rather, "the province of all mankind",[408] States retain jurisdiction, control and ownership over satellites they launch and register.[409] It is reasonable, therefore, to consider satellites as part of a State's territory, and hence, the satellites of neutral States should not be attacked by belligerents.

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[404] *1998 IGA*, *supra* note 109, art 1 [emphasis added].

[405] "The term 'neutrality' designates the legal status of a State which does not participate in a war being waged by other States." *Encyclopedia of Public International Law*, vol. 4 (Amsterdam: North-Holland, 1982) at 9-10.

[406] *Ibid.* at 17.

[407] "The territory of neutral Powers is inviolable." *Hague Convention (V) Respecting the Rights and Duties of Neutral Powers and Persons in Case of War on Land*, 18 October 1907, 1 Bevans 654, art. 1 [*Hague V*].

[408] *Outer Space Treaty*, *supra* note 48, art. I.

[409] "A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in space or on a celestial body. Ownership of objects launched into outer space ... is not affected by their presence in outer space or on a celestial body or by their return to the Earth." *Outer Space Treaty*, *supra* note 48, art. VIII.

Under the law of neutrality, a neutral State does not have to prevent the export to a belligerent "of arms, munitions of war, *or, in general, of anything which can be of use to an army* or a fleet."[410] Meaning, even though it can't aid a belligerent, nothing in the basic laws of neutrality requires a neutral State to prevent its citizens from aiding a belligerent. There is a significant difference when dealing with space assets, however. Under the *Outer Space Treaty*, a State is responsible for all of its space activities—whether governmental or non-governmental. Specifically,

> States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies *or by non-governmental entities* ... The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and *continuing supervision* by the appropriate State Party to the Treaty.[411]

Given this provision, it is fair to conclude that under the *Outer Space Treaty* a State is responsible to prevent its citizens and private corporations from using space assets to provide aid to belligerent States. Using this reasoning, U.S. Army judge advocate, Major David Willson, argued, "during armed conflict, the United States may legally interfere with a neutral country's commercial satellites (and ground support systems) if they are supporting enemy operations."[412]

The USAF also seems to take this position in its *Counterspace Operations* document:

> Even an adversary without indigenous space assets may use space through US, allied, commercial, or consortium space services. These services

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[410] *Hague V*, *supra* note 407, art. 7 (emphasis added).

[411] *Outer Space Treaty*, *supra* note 48, art. VI.

[412] David L. Willson, "An Army View of Neutrality in Space: Legal Options for Space Negation" (2001) 50 A.F.L. Rev. 175 at 176.

> include precision navigation, high-resolution imagery, environmental monitoring, and satellite communications. Denying adversary access to space capability and protecting US and friendly space capability may require taking the initiative to preempt or otherwise impede an adversary.[413]

Contemplated responses include disrupting, denying, degrading, or destroying the space system.[414]

The only questionable part of this policy was the reference to satellite communications. *Hague (V)* specifically permits a neutral State to allow belligerents to use communications equipment (whether belonging to the State, companies or private individuals). Specifically, it provides, "[a] neutral Power is not called upon to forbid or restrict the use on behalf of the belligerents of telegraph or telephone cables or of wireless telegraphy apparatus belonging to it or to Companies or private individuals."[415] Applying this to communications satellites, as "other apparatus for the purpose of communicating," it appears that a neutral State can legally either allow or prohibit belligerent States the use of its communications satellites as long as it treats all of the belligerent States alike.[416]

One possible response to this line of reasoning is to argue that the law of neutrality ceased to apply after the creation of the U.N. Charter. The Charter specifically provides, "[a]ll Members shall give the United Nations every assistance in any action it takes in accordance with the present Charter, and shall refrain from giving assistance to

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[413] U.S., *Counterspace Operations*, *supra* note 130 at 31.

[414] *Ibid.*

[415] *Hague V*, *supra* note 407, art. 8.

[416] "Every measure of restriction or prohibition taken by a neutral Power in regard to the matters referred to in Articles 7 and 8 must be impartially applied by it to both belligerents." *Ibid.*, art. 9.

any state against which the United Nations is taking preventive or enforcement action."[417] On its face, this provision seems to negate the existence of any neutral States.

Another foreseeable problem on the subject of neutrality is that an ASAT attack on a satellite belonging to a belligerent may affect the satellites of neutral parties—either by the creation of debris that is dangerous to other satellites, or via collateral damage (e.g., if a nuclear ASAT were used and a neutral State's satellites were destroyed by the blast's electromagnetic pulse). These effects would be contrary to the obligation of holding a neutral State's territory inviolable. The appropriate remedy for the neutral State would likely be to seek compensation under the *Liability Convention*, but recovery, as will discussed in the chapter on debris, will depend on proof of fault or negligence.

Yet another potential problem is that many satellites (106 of 847) are multinational.[418] Hence, a satellite could be owned by both a belligerent and a neutral party. This is problematic, as the neutral State's territory must be kept inviolable, and yet the belligerent State's territory is subject to attack as long as it is making an effective contribution to military action and if the attack against this satellite would offer a definite military advantage.[419]

C. Militarization / Weaponization of Outer Space

The *Outer Space Treaty* is one of only five treaties that make up the body of space law (the other space treaties include the *Liability Convention*,[420] the *Registration*

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[417] *Charter of the United Nations*, art. 2(5).

[418] UCS Satellite Database, *supra* note 17.

[419] *Protocol I*, *supra* note 396, art. 52(2).

[420] *Convention on International Liability for Damage Caused by Space Objects*, 29 March 1972, 961 U.N.T.S. 187, 24 U.S.T. 2389 [*Liability Convention*].

Convention,[421] the *Rescue and Return Agreement*,[422] and the *Moon Treaty*[423]). The *Outer Space Treaty*[424] has been variously described as the "Magna Carta," the "Bible" or the "constitution" of outer space law. It is most famous for establishing three key principles of outer space law. First, it established the "common interest" principle, providing that space shall be used for the benefit of all mankind.[425] Second, it established the "freedom principle" which provides that space is free for exploration and use by all States.[426] Third, it established the "principle of non-appropriation" which provides that no State can claim ownership of any part of outer space—preventing empire building in space.[427]

More significantly for the purposes of this thesis, however, the *Outer Space Treaty* partially demilitarized space. Specifically, Article IV prevented States from placing nuclear weapons and other weapons of mass destruction in orbit around the

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[421] *Registration Convention*, supra note 19.

[422] *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space*, 22 April 1968, 672 U.N.T.S. 119, 19 U.S.T. 7570.

[423] *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*, 18 December 1979, 1363 U.N.T.S. 3. This treaty was never ratified by the U.S., in fact, it has only been ratified by twelve States and signed by another four. United Nations Office for Outer Space Affairs, "United Nations Treaties and Principles on Space Law," online: United Nations Office for Outer Space Affairs <http://www.unoosa.org/oosa/en/SpaceLaw/treaties.html> (accessed 22 May 2007).

[424] *Outer Space Treaty*, *supra* note 48.

[425] "The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind." *Ibid.*, art. I, para. 1.

[426] "Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies." *Ibid.*, art. I, para. 2.

[427] "Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means." *Ibid.*, art. II.

Earth.[428] This does not, however, prevent States from sending a missile equipped with a nuclear warhead in transit through space—it only prevents them being placed into orbit (a complete revolution around the Earth).[429] The *Outer Space Treaty* also prohibits States from installing such weapons on the moon or on other celestial bodies.[430] Paragraph IV went on to say that the "moon and other celestial bodies shall be used by all States exclusively for *peaceful purposes*."[431] It also forbade the establishment of military bases, the testing of any types of weapons or the conduct of military maneuvers on celestial bodies.[432] It did, however, permit the use of military personnel for scientific research "or for any other peaceful purposes".[433]

1. Peaceful Purposes

In a letter from President Dwight D. Eisenhower to the Chairman of the USSR's Council of Ministers in 1958, he wrote: "I propose that we agree that outer space should be used only for peaceful purposes. We face a decisive moment in history in relation to this matter ... Should not outer space be dedicated to the peaceful uses of mankind and denied to the purposes of war? That is my proposal."[434]

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[428] "States Parties to the Treaty undertake not to place in orbit around the earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner." *Ibid.*, art. IV, para. 1.

[429] Cheng, *supra* note 49 at 410.

[430] *Id.*

[431] *Outer Space Treaty*, *supra* note 48, art. IV, para. 2 [emphasis added].

[432] *Ibid.*

[433] *Ibid.*

[434] Letter from President Dwight D. Eisenhower to Nikolai Bulganin (13 January 1958) online: The Eisenhower Institute <http://www.eisenhowerinstitute.org/programs/globalpartnerships/fos/newfrontier/letters.htm#letter1> (accessed 10 July 2007).

That same year, the United Nations issued a General Assembly resolution entitled, "Question of the Peaceful Use of Outer Space."[435] It began loftily, "[r]ecognizing the common interest of mankind in outer space and recognizing that it is the common aim that *outer space should be used for peaceful purposes only* ...."[436]

This resolution established the *ad hoc* Committee on the Peaceful Uses of Outer Space, made up of members from 18 States. A year later, this committee was enlarged to 24 States and "*ad hoc*" was removed from its name and it became the Committee on the Peaceful Uses of Outer Space (COPUOS).[437] Since that time COPUOS membership has grown to 67 States and has two subsidiary bodies, the Legal Subcommittee and the Scientific and Technical Subcommittee.[438] COPUOS convenes annually and has, from the beginning, been devoted to the peaceful uses of outer space. COPUOS is responsible for the creation of all five space treaties—forming the backbone of space law.

COPUOS's most important contribution to space law, and the peaceful uses of space, was the drafting of the *Outer Space Treaty*. The *Outer Space Treaty*'s preamble provides, in relevant part, "[r]ecognizing the common interest of all mankind in the progress of the exploration and use of outer space for *peaceful purposes*, [and] Desiring to contribute to broad international co-operation in the scientific as well as the legal aspects of the exploration and use of outer space for peaceful purposes ...."

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[435] *Question of the peaceful use of outer space*, GA Res. 1348 (XIII), UN GAOR, 13th Sess., (1958).

[436] *Ibid.* [emphasis added].

[437] *International co-operation in the peaceful uses of outer space*, GA Res. 1472 (XIV), UN GAOR, 14th Sess., (1959).

[438] *Report of the Committee on the Peaceful Uses of Outer Space*, UN GAOR, 61st Sess., Supp. No. 20, UN Doc. A/61/20 (2006) 1 at 2.

The *Outer Space Treaty* also used the phrase, "peaceful purposes" when limiting the use of the moon and other celestial bodies: "[t]he moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes."[439] The language the authors chose was nearly identical to the language used in the 1959 *Antarctic Treaty*[440] which demilitarized Antarctica. The *Antarctic Treaty* provides: "Antarctica shall be used for peaceful purposes only. There shall be prohibited, *inter alia*, any measure of a military nature, *such as* the establishment of military bases and fortifications, the carrying out of military manoeuvres, as well as the testing of any type of weapon."[441] Further, "[t]he present Treaty shall not prevent the use of military personnel or equipment for scientific research or for any other peaceful purpose."[442]

The *Outer Space Treaty* also uses the phrase "peaceful exploration and use" in article IX, which provides, in part:

> If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with the activities of other States Parties in the *peaceful exploration and use of outer space*, including the moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment.[443]

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[439] *Outer Space Treaty*, *supra* note 48, art. IV(2).

[440] *Antarctic Treaty*, 1 December 1959, 402 U.N.T.S. 71 [*Antarctic Treaty*].

[441] *Ibid.*, art. 1(1) [emphasis added]. The use of the words, "such as" before listing some military activities, makes it clear that these are just some examples of State action that are prohibited by the treaty. The language used in article IV(2) of the *Outer Space Treaty*, intentionally or not, does not read like a list of examples, but rather an exclusive list of prohibited activities: "The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on celestial bodies shall be forbidden." *Outer Space Treaty*, *supra* note 48, art. IV(2).

[442] *Antarctic Treaty*, *supra* note 440, art. 1(2). Likewise, the *Outer Space Treaty* provides, "[t]he use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited. The use of any equipment or facility necessary for peaceful exploration of the moon and other celestial bodies shall also not be prohibited." *Outer Space Treaty*, *supra* note 48, art. IV(2).

[443] *Outer Space Treaty*, *supra* note 48, art IX [emphasis added].

President John F. Kennedy, in an address to the U.N. General Assembly in 1961, commented, "we shall urge proposals extending the United Nations Charter to the limits of man's exploration in the universe, reserving outer space for peaceful use, prohibiting weapons of mass destruction in space or on celestial bodies, and opening the mysteries and benefits of space to every nation."[444]

At the signing of the *Outer Space Treaty* on January 27, 1967, President Lyndon B. Johnson commented:

> We have never succeeded in freeing our planet from the implements of war. But if we cannot yet achieve this goal here on earth, we can at least keep the virus from spreading. We can keep the ugly and wasteful weapons of mass destruction from contaminating space. And that is exactly what this treaty does. This treaty means that the moon and our sister planets will serve only the purposes of peace and not of war.[445]

Finally, such remarks found their way into the United States Code, which expressly provides, "[t]he Congress declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind."[446]

All of the above firmly establishes that outer space is to be used for peaceful purposes—and only peaceful purposes. In light of the above, it may seem surprising that there is considerable debate on whether or not outer space can be used for military purposes. The question of what "peaceful purposes" actually means has been the subject of much controversy from the very beginning of the space age.

2. U.S. position that "peaceful" means "non-aggressive"

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[444] U.S., 45 Dept. of State Bulletin 619 (25 September 1961).

[445] Lyndon B. Johnson, "President Lyndon B. Johnson's Remarks at the Signing of the Treaty on Outer Space" (27 January 1967), online: Lyndon Baines Johnson Library and Museum <http://www.lbjlib.utexas.edu/johnson/archives.hom/speeches.hom/670127.asp> (accessed 5 July 2007).

[446] 42 U.S.C. § 2451 (2000).

The U.S. has consistently held that the term "peaceful purposes" means "non-aggressive purposes" (with the possible exception of President Eisenhower). Senator Albert Gore, Sr., representing the United States to the United Nations in 1962 asserted:

> It is the view of the United States that outer space should be used only for peaceful—that is non-aggressive and beneficial—purposes. The question of military activities in space cannot be divorced from the question of military activities on earth. To banish these activities in both environments we must continue our efforts for general and complete disarmament with adequate safeguards. Until this is achieved, the test of any space activities must not be whether it is military or non-military, but whether or not it is consistent with the United Nations Charter and other obligations of law.[447]

The U.S.'s *2006 National Space Policy* affirms this position: "'peaceful purposes' allow U.S. defense and intelligence-related activities in pursuit of national interests ...."[448]

The U.S. position that "peaceful" use of outer space merely means "non-aggressive" is also entrenched in current military doctrine. Air Force doctrine says the following of "peaceful purposes":

> The [*Outer Space Treaty*] recognizes "the exploration and use of outer space for peaceful purposes." The majority of nations have traditionally held that the "peaceful purposes" language does not prohibit military activities in outer space; such activities have taken place throughout the space age without significant international protest. The phase, rather, has been interpreted to require that activities in space be non-aggressive, or in other words in compliance with the requirements under the United Nations Charter and international law to refrain from the threat or use of force, except in accordance with the law, such as in self-defense or pursuant to United Nations Security Council authorization.[449]

3. Position that "peaceful" means "non-military"

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[447] UN GAOR, 17th Sess., 1289th Mtg., UN Doc. A/C.1/PV.1289 (1962).

[448] U.S., *2006 National Space Policy*, *supra* note 126 at 1.

[449] U.S., *Space Operations*, *supra* note 79 at 27.

Taking the other side of the argument, many scholars advocate that "peaceful" means "non-military." Hence, they argue that outer space should not be used for any military use.

Professor Bin Cheng, a pioneer of international space law, argued against the U.S. interpretation of "peaceful purposes" to mean "non-aggressive" rather than "non-military." Professor Cheng argued the U.S. position was needless, wrong and potentially noxious.[450] He believed the U.S. position "needless" as he saw no reason to suggest the U.S. intended to conduct military activities on the moon or other celestial bodies.[451] Professor Cheng believed the U.S. position "wrong" because aggressive acts were already prohibited, not only on the moon and other celestial bodies—but throughout the entire universe—pursuant to Article 2(4) of the U.N. Charter.[452] This being the case, to merely parrot that this universal rule also applies on the moon and other celestial bodies is nonsensical and adds no value whatsoever to the *Outer Space Treaty*—hence, Professor Cheng argues, "if the word 'peaceful' in Article IV(2) [of the *Outer Space Treaty*] is to have any meaning at all, it must bear its plain meaning of 'non-military' and can certainly not mean non-aggressive.'"[453] Professor Cheng found the U.S. interpretation of "peaceful" to be "potentially noxious" for fear that this interpretation of "peaceful" as "non-aggressive" could influence a like interpretation in other international

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[450] Cheng, *supra* note 49 at 520-22.

[451] This position is referring solely to the requirement of article IV(2) of the *Outer Space Treaty* to use the moon and other celestial bodies "exclusively for peaceful purposes." Professor Cheng's point neglects to consider the other provisions of the *Outer Space Treaty* calling for the peaceful use of outer space as a whole. *Ibid.* at 520.

[452] *Ibid.* at 521.

[453] *Ibid.*

agreements requiring "peaceful" usages—for example, the *Antarctic Treaty* and multilateral and bilateral treaties regarding nuclear matters.[454]

Professor Ivan Vlasic, noted that "non-military" was the "widely accepted interpretation" of "peaceful uses" "prior to and immediately after the advent of the space age …."[455] He also argued that to define "peaceful" as "non-aggressive" would be contrary to the ordinary meaning of the word "peaceful."[456] Professor Vlasic acknowledged, however, that the early interpretation of "peaceful uses" to mean "non-military" was quickly "contradicted by the practice of states"—referring to the numerous launches of military satellites by the U.S. and the Soviet Union between the launch of Sputnik in October of 1957 and the adoption of the *Outer Space Treaty* in January 1967.[457] It is also relevant to point out that at the time of the signing of the *Outer Space Treaty*, the U.S.'s Program 437 (with its nuclear tipped Thor missiles) was operational—and it remained operational until 1975. The USSR's co-orbital ASAT system was also operational at the time of signing the *Outer Space Treaty* as it tested this satellite from 1968 until 1982.[458] Hence, at the time the *Outer Space Treaty* was signed (including its provisions on the peaceful uses of outer space) both the U.S. and the USSR had military satellites and anti-satellite systems. In the end, Professor Vlasic was led to conclude, "the conclusion is inescapable that all military uses of space other than those prohibited by treaty were—since the beginning of space exploration and are still today—lawful as long

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[454] *Ibid.* at 521-22.

[455] Vlasic, Ivan A. "The Legal Aspects of Peaceful and Non-Peaceful Uses of Outer Space" in B. Jasani, ed., *Peaceful and Non-Peaceful Uses of Space* (New York: Taylor & Francis, 1991) 37 at 37.

[456] *Ibid.* at 44-45.

[457] *Ibid.* at 37.

[458] O'Hanlon, *supra* note 159 at 10-11.

as they do not violate any of the principles and rules of general international law (e.g., uses that represent the threat of or employment of force)."[459]

Other problems with construing "peaceful" to mean "non-military" include the difficulty in determining what constitutes a military activity—are communications a military activity? How about navigation, remote-sensing, weather prediction, and manned space missions? All of these space activities are widely used by military and civilian populations.

The weaponization of space (i.e., the stationing of weapons in outer space), unlike the extensive militarization of space, has not yet taken place. No nation has yet stationed a weapon of any kind in outer space. There have, however, been *plans* for both stationing weapons in space[460] and for stationing ballistic missile defense systems in space. Though not illegal, the wisdom of pursuing such technology is questionable—because of its potential to spark an arms race in space,[461] provoke a war,[462] or simply because of such a system's enormous cost. As long as the weapons were neither nuclear nor otherwise a weapon of mass destruction, such weapons would not be illegal under the *Outer Space Treaty*.

D. Additional Nonproliferation Efforts in Outer Space

1. The Limited Nuclear Test Ban Treaty

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[459] Vlasic, *supra* note 455 at 45.

[460] For example, in 2003, the USAF listed "hypervelocity rod bundles" as a "future system concept" that would "provide the capability to strike ground targets anywhere in the world from space." U.S., *Transformational Flight Plan*, *supra* note 52 at D-7.

[461] Rob Watson, "China test sparks space arms fears" *BBC News* (19 January 2007), online: BBC News <http://news.bbc.co.uk/2/hi/asia-pacific/6278867.stm> (accessed 11 June 2007).

[462] "In a recent space war game, U.S. commanders found that preemptively destroying or denying an opponent's space-based information assets could lead to rapid escalation into full-scale war, even triggering nuclear weapon use." DeBlois, *supra* note 191 at 66.

In August of 1963, the U.S., the U.K. and the USSR signed the *Limited Nuclear Test Ban Treaty*.[463] It has since been ratified by 124 States.[464] The purpose of this treaty is to "achieve the discontinuance of all test explosions of nuclear weapons for all time ...."[465] Pursuant to its terms, each State "undertakes to prohibit, to prevent, and not to carry out any nuclear weapon test explosion, or any other nuclear explosion, at any place under its jurisdiction or control: (a) in the atmosphere; beyond its limits, *including outer space*; or underwater, including territorial waters or high seas ...."[466] States are still permitted by this treaty, however, to conduct nuclear test explosions underground.

In spite of the language "or any other nuclear explosion," in keeping with the title of the treaty, it does not prohibit the use of nuclear weapons, including nuclear ASATs, in war, but only the "testing" of nuclear weapons.[467] In President John F. Kennedy's letter of transmittal to the Senate, for their "advice and consent," President Kennedy noted, that the treaty would "radically limit the testing in which both nations [the U.S. and the USSR] would otherwise engage."[468] He continued, however, that it would not "outlaw the use of nuclear weapons" nor prohibit "all nuclear tests" (controlled explosions

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[463] *Limited Nuclear Test Ban Treaty*, *supra* note 150.

[464] "Status of Multilateral Arms Regulation and Disarmament Agreements" online: United Nations Office for Disarmament Affairs (UNODA) <http://disarmament.un.org/TreatyStatus.nsf> (accessed 30 May 2007).

[465] *Limited Nuclear Test Ban Treaty*, *supra* note 150, preamble.

[466] *Ibid.*, art I(1)(a)[emphasis added].

[467] Cheng, *supra* note 49 at 527.

[468] U.S., *Nuclear Test Ban Treaty: Message from the President of the United States Transmitting the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water to the Senate of the United States*, 2 I.L.M. 883, 884 (1963).

underground in a State's own territory were still permissible).[469] It is also important to note that two of the world's nuclear powers, China and France, are still not Parties to this treaty.

2. The Nuclear Non-Proliferation Treaty

Five years later, another non-proliferation treaty was signed. This treaty, the *Nuclear Non-Proliferation Treaty*, provided that nuclear weapon States (the five Nations that had manufactured and exploded a nuclear weapon prior to 1 January 1967),[470] would not transfer nuclear weapons to any recipient, nor would they encourage or assist a non-nuclear weapon State from seeking to acquire a nuclear weapon.[471]

The stated purpose of the treaty was to "achieve at the earliest possible date the cessation of the nuclear arms race and to undertake effective measures in the direction of nuclear disarmament ...."[472] There are only four States that are not party to this treaty—India, Pakistan Israel and North Korea—notably, all of these States, with the possible exception of North Korea, already possess nuclear weapons.[473] The near universality of this treaty, however, has positively limited the number of States capable of exploding a nuclear device in outer space.

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[469] *Ibid.*

[470] "[A] nuclear-weapon State is one which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to January 1, 1967." *Treaty on the Nonproliferation of Nuclear Weapons*, 1 July 1968, 729 U.N.T.S. 161, art. IX(3) [*Nuclear Nonproliferation Treaty*].

[471] "Each nuclear-weapon State Party to the Treaty undertakes not to transfer to any recipient whatsoever nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices directly, or indirectly; and not in any way to assist, encourage, or induce any non-nuclear weapon State to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or control over such weapons or explosive devices." *Ibid.* art. I.

[472] *Ibid.*, preamble.

[473] "Status of Multilateral Arms Regulation and Disarmament Agreements" online: United Nations Office for Disarmament Affairs (UNODA) <http://disarmament.un.org/TreatyStatus.nsf> (accessed 30 May 2007).

3. The Anti-Ballistic Missile Treaty of 1972

In 1972, the U.S. and the USSR signed the *Anti-Ballistic Missile Treaty*.[474] Pursuant to this treaty, the U.S. and the USSR agreed not to deploy anti-ballistic missile systems (missiles, launchers and radar systems constructed and deployed for an anti-ballistic missile role[475]) except for one such system, having a radius of 150 km centered around each State's capital,[476] and another such system, having the same 150 km radius to protect the State's intercontinental ballistic missiles.[477] Article V of this treaty specifically prohibited the U.S. and USSR from developing, testing, or deploying an anti-ballistic missile system that was "sea-based, air-based, *space-based*, or mobile land-based."[478]

The purpose of this treaty was to curb "the race in strategic offensive arms" and decrease "the risk of outbreak of war involving nuclear weapons."[479] By limiting each State's defense to nuclear war, the States ensured that any such war would result in the utter destruction of both States ("mutually assured destruction").

Additionally, article XII of the *Anti-Ballistic Missile Treaty* provided that "[e]ach Party undertakes not to interfere with the national technical means of verification of the other Party ...."[480] This provision has been interpreted as a restriction against interfering

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[474] *Anti-Ballistic Missile Treaty*, *supra* note 246.

[475] *Ibid.*, art. II(1).

[476] *Ibid.*, art. III(a).

[477] *Ibid.*, art. III(b).

[478] *Ibid.*, art. V(1) [emphasis added].

[479] *Ibid.*, preamble.

[480] *Ibid.*, art. XII(2).

with another State's surveillance satellites—the technical means used to verify that each State was abiding by its agreement to limit its anti-ballistic missile systems. This identical provision is also found in other treaties (e.g., *SALT I*[481] and *SALT II*[482]).

According to the terms of the *Anti-Ballistic Missile Treaty*, both the U.S. and the USSR had the "right to withdraw from this Treaty if it decides that *extraordinary events related to the subject matter of this Treaty* have jeopardized its supreme interests."[483] This agreement was in force between the U.S. and the USSR (and later Russia) for 30 years. On 13 June 2002, the U.S. withdrew from the treaty, after giving the required 6-months notice. The White House Press Secretary issued this reasoning supporting the U.S. withdrawal:

> Today, the United States and Russia face new threats to their security. Principal among these threats are weapons of mass destruction and their delivery means wielded by terrorists and rogue states. A number of such states are acquiring increasingly longer-range ballistic missiles as instruments of blackmail and coercion against the United States and its friends and allies.[484]

Such reasoning is hardly "related to the subject matter of this treaty" and hence, the U.S. withdrawal from the treaty was likely against the terms expressly provided for in the *Anti-Ballistic Missile Treaty* that allowed for withdrawal. Regardless, however, the

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[481] *Interim Agreement Between the United States of America and the Union of Soviet Socialist Republics on Certain Measures with Respect to the Limitation of Strategic Offensive Arms*, 26 May 1972, 944 U.N.T.S. 13445, art. V(2) [*SALT I*].

[482] *Treaty Between the United States of America and the Union of the Soviet Socialist Republics on the Limitation of Strategic Offensive Arms, Together with Agreed Statements and Common Understandings Regarding the Treaty*, 18 June 1979, art. XV(2), online: Federation of American Scientists <http://www.fas.org/nuke/control/salt2/text/salt2-2.htm> [*SALT II*] (this treaty was signed, but never ratified, in response to the Soviet invasion of Afghanistan in December 1979) (accessed 5 July 2007).

[483] *Anti-Ballistic Missile Treaty*, *supra* note 246, art. XV(2) [emphasis added].

[484] U.S., White House Press Secretary, "ABM Treaty Fact Sheet" (13 December 2001), online: U.S. Department of State <http://www.state.gov/t/ac/rls/fs/2001/6848.htm> (accessed 22 May 2007).

U.S. withdrew. The main significance of this withdrawal was the removal of a legal obstacle to the creation of an anti-ballistic missile system. As discussed earlier, any BMD system will not only have inherent ASAT capabilities, but, if space-based, will provide great incentive to other States to further invest in ASATs.

This Chapter has analyzed the general illegality of using force or even the threat of using force. It discussed the exception for self-defense. It discussed how LOAC applies in outer space, the legality of attacking all satellites that were lawful military objectives (which would likely include almost all satellites), and also the problem that nearly all attacks on a belligerent's satellite would likely harm the satellite's belonging to neutral States. This Chapter also reviewed the long-fought debate over the militarization and weaponization of space and concluded with a review of non-proliferation efforts in Space.

Having covered this wide range of issues all directly related to the military use of ASATs, the next chapter turns to a side effect of ASAT use—space debris—a normal consequence of many types of ASATs. If mankind does not find a way to handle this problem, all future use of space is at risk.

Chapter Five: Debris

A. Background Information

One of the frequently cited problems with ASATs is the creation of debris in orbit. There is a lot of debris in outer space, both natural debris (e.g., dust, asteroids, and comets) and as of the last 50 years, man-made debris. Man-made debris includes inactive satellites (normally, satellites that have run out of fuel), pieces or components of satellites (e.g., rocket bodies and fuel tanks), and fragmentation debris (e.g., pieces of satellites destroyed by ASATs, debris from explosions caused by leftover rocket fuel in rocket upper stages,[485] and also debris caused by rare collisions between satellites). Sometimes objects serving no useful purpose whatsoever are released into outer space. For example, some eccentric individuals have had their cremated human remains released into space.[486] Another eccentric example involves a Canadian company, which in November 2006 paid the Russian Space Agency to have one of its astronauts tee-off on a miniature golf ball from the International Space Station.[487] Contrary to NASA's predictions that the golf

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[485] Half of all catalogued debris comes from explosions of space objects—both deliberate explosions (including ASATs) and also accidental explosions from upper stages and spacecraft batteries. U.S., Office of Science and Technology Policy, *Interagency Report on Orbital Debris* (November 1995) at 2 [U.S., *Interagency Report*].

[486] South Korea launched Kompsat-1 from the United States in 1999. Kompsat-1, though primarily a remote-sensing satellite, also released three dozen capsules of human remains. UCS Satellite Database, *supra* note 15. See also Mahulena Hofmann, "Space Cemeteries—A Challenge for the Legal Regime of Outer Space" (2001) *Proceedings of the Forty-third Colloquium on the Law of Outer Space* 380.

[487] Traci Watson, "Golf drive to be measured in miles, not yards" *USA Today* (16 November 2006), online: USA Today <http://www.usatoday.com/tech/science/space/2006-11-16-space-golf_x.htm> (accessed 18 June 2007).

ball would burn up in the Earth's orbit within three days, the ball is still orbiting the Earth (perhaps heading more towards Russia's estimate of a 3.5 year lifespan).[488]

USAF Space Command currently tracks over 15,000 space objects.[489] Among these objects are over 1,000 pieces of debris from China's January 2007 ASAT test.[490] The U.S. cannot track objects smaller than 10 cm (the size of a baseball).[491] This being the case, an estimated 2 million pieces of debris measuring between 1 mm and 1 cm and another 40,000 pieces of debris measuring between 1 cm and 10 cm caused by the China's January 2007 ASAT test are not being tracked.[492]

ASAT tests by the U.S. and Russia also caused a lot of debris. The USAF's 1985 ALMV ASAT test against the Solewind P78-1 satellite created 230 pieces of trackable debris. This last of this debris remained in orbit for 17 years.[493] Debris from the January 2007 Chinese ASAT, due to the high altitude at collision, is expected to remain in orbit for over 100 years.[494]

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[488] The progress of the golf ball is trackable on the website operated by Element 21, the Canadian company that sponsored the shot. "Longest Golf Drive in History", online: E21 <http://www.e21.ca/golf_ball_tracking> (accessed 7 July 2007). As of 7 July 2007, the golf ball had already traveled over 98 million miles and been in orbit over seven months.

[489] U.S., Chilton Testimony, *supra* note 80 at 6.

[490] *Ibid.* at 7.

[491] The U.S. tracks space objects using its Space Surveillance Network (SSN), consisting of 25 ground-based radar and optical sensors operated worldwide. "Space Surveillance," online: United States Space Command <http://www.au.af.mil/au/awc/awcgate/usspc-fs/space.htm> (accessed 18 June 2007).

[492] Wright, *supra* note 6.

[493] Noah Shachtman, "China Space Attack: Unstoppable" *The Huffington Post* (18 January 2007), online: The Huffington Post <http://www.huffingtonpost.com/noah-shachtman/china-space-attack-unsto_b_38999.html> (quoting Theresa Hitchens, analyst for the Center of Defense Information)(accessed 18 June 2007).

[494] Jessica West, "Fallout from China's anti-satellite test" (Spring 2007) 28:1 *The Ploughshares Monitor*, online: Ploughshares <http://www.ploughshares.ca/libraries/monitor/monm07a.pdf> (accessed 10 June 2007).

How long a piece of debris will remain in orbit depends on several factors—most notably its area, mass and attitude.[495] An object less than 600 km from the Earth will normally fall back to Earth within a few years.[496] At around 800 km, an object will fall within decades.[497] "Above 1000 km, orbital debris will normally continue circling the Earth for a century or more."[498] An object in Geostationary Earth Orbit will remain in orbit for over a million years.[499]

The speed of debris also varies depending on its altitude. In general, the closer an orbiting object is to Earth, the faster it must be traveling to remain in orbit. In Low Earth Orbit, the average speed at collision between any two objects is 10 km/s.[500] In contrast, objects in Geostationary Earth Orbit are traveling much slower—around 800 m/s.[501]

This debris is concerning on two fronts, both recognized early in space law. First, falling debris could cause damage to whatever it hits on the Earth, especially if the falling debris is radioactive.[502] Second, while still in space, debris can collide with satellites

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[495] U.S., *Interagency Report*, *supra* note 485 at 6.

[496] "Orbital Debris: Frequently Asked Questions," online: NASA Orbital Debris Program Office <http://www.orbitaldebris.jsc.nasa.gov/faqs.html#3> (accessed 17 June 2007).

[497] *Ibid.*

[498] *Ibid.*

[499] U.S., *Interagency Report*, *supra* note 485 at 8.

[500] Mark Williamson, *Space: The Fragile Frontier* (Reston: AIAA, 2006) at 50.

[501] *Ibid.* at 51.

[502] For example, a 1972 report prepared for Congress prior to the signing of the *Liability Convention* specifically reported 44 known cases of space objects landing on Earth. Two of the objects actually hit ships in the oceans. U.S., Senate Comm. on Aeronautical and Space Sciences, 92d Cong., 2d Sess., *Staff Report: Convention on International Liability for Damage Caused by Space Objects: Analysis and Background Data* (Washington, D.C.: United States Government Printing Office, 1972) at 74-75 [U.S., *Staff Report on Liability Convention*].

belonging to other States. To cover both contingencies, States created the *Liability Convention of 1972*.[503]

B. Damages Caused on Earth

The *Liability Convention*, one of the five space treaties, provides a framework for holding States financially liable for their outer space activities when their activities cause damage to another State. The *Liability Convention* has two separate liability regimes depending on where the damage is caused.

For damage on the Earth, (i.e., caused by falling debris) and for damage to objects in flight (i.e., collisions with aircraft) the liability regime provides for absolute liability on part of the "launching State." Specifically, it provides, "[a] launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the Earth ...."[504] Remarkably, the State bears broad responsibility for outer space activities "whether such activities are carried on by governmental agencies or by non-governmental entities."[505] Hence, a State is liable for damage caused by the space activities of its corporations.

The *Liability Convention* does not provide a definition for "absolute liability." The *Liability Convention* expressly provides for several caveats to this "absolute liability" ("almost absolute liability" would be more accurate). First, the "damage" that a State is liable for is explicitly defined. "The term "damage" means loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of

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[503] *Liability Convention*, *supra* note 420.

[504] *Ibid.*, art. II.

[505] *Outer Space Treaty*, *supra* note 48, art. VI.

persons, ..."[506] Though one of the very few terms actually defined within a space treaty, the definition of "damage" is very problematic. There is much debate on whether indirect damages are recoverable. The Staff Report prepared for consideration by the U.S. Senate prior to ratification of the *Liability Convention* noted the vague definition of damage "may become one of the major problem areas of the Convention."[507] Noticeably absent are damages for lost profits, pain and suffering, and other indirect damages. Second, there are explicit exceptions to the "absolute" liability. Article VI provides that States will be "exonerated" from absolute liability "to the extent that a launching State establishes that the damage has resulted wholly or partially from gross negligence or from an act or omission done with intent to cause damage on the part of a claimant State or of natural or juridical persons it represents."[508] This is a rather odd combination—a general regime of liability without regard to fault, where recovery can be somehow diminished, or even eliminated, by the fault of the claimant.

Article VII contains another couple of exemptions to "absolute liability." The Convention doesn't apply to damage caused to a State's own nationals[509] or to those "participating in the operation of that space object" including those that are merely "in the immediate vicinity of a planned launching or recovery area as the result of an invitation by that launching State."[510] In light of all of these caveats on "absolute liability," it is more accurate just to note that a State is liable, *in accordance with the*

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[506] *Liability Convention, supra* note 420, art. I(a).

[507] U.S., *Staff Report on Liability Convention, supra* note 502 at 23.

[508] *Liability Convention, supra* note 420, art. VI(1).

[509] *Ibid.*, art. VII(b).

[510] *Ibid.*

provisions of the Liability Convention, for damages caused on the surface of the Earth or to objects in flight.

By 2002, over 18,000 trackable objects had re-entered the Earth's atmosphere, having a total mass of around 27,000 tons.[511] During re-entry, the rapid reduction of the speed of an object creates so much heat energy that the majority of the objects burn up.[512] Still, between 10 and 40 percent of the mass of the larger objects might have landed on Earth.[513] The most tragic re-entry was undoubtedly the breakup of the Space Shuttle Columbia on 1 February 2003, which after losing a small piece of its protective foam insulation could not withstand the heat of re-entry.[514] A total of 84,000 fragments from Columbia were recovered from a 1,000 km by 40 km area of Texas.[515] Many other large satellites have fallen to the Earth, including the controlled re-entry of the Russian Mir space station (having a mass of 135,000 kg and re-entering on 23 March 2001), and the uncontrolled re-entry of the U.S. Skylab (having a mass of 74,000 kg and re-entering on 11 July 1979).[516]

The chances of being directly hit by a piece of space debris are almost non-existent.[517] According to the calculations of Heiner Klinkrad, Senior Mission Analyst for the European Space Operations Centre, "[t]he annual risk of a person being killed by a re-

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[511] Heiner Klinkrad, *Space Debris: Models and Risk Analysis* (Chichester: Springer, 2006) at 241.

[512] *Ibid.*

[513] *Ibid.*

[514] *Ibid.* at 243.

[515] *Ibid.*

[516] *Ibid.*

[517] There is, however, one documented case from 1969 when five Japanese sailors aboard a cargo boat were injured by falling debris. Cheng, *supra* note 49 at 287.

entering man-made space object is equivalent to the risk of being killed while traveling 1 meter in a car, doing 10 seconds of skiing, working 1 second as a fire fighter, or spending 5 minutes of your life at the age of 60."[518]

The foregoing analysis shows that the risks associated with being hit by a piece of falling space debris are incredibly minuscule. Furthermore, even if some falling debris caused damage on Earth, the *Liability Convention* currently provides a means for recovery from the State whose space object damaged the lives or property of another State.

The real risk of falling debris, however, is when the debris happens to be radioactive. A total of 36 space activities between 1965 and 1988 (35 by Russia, 1 by the U.S)[519] derived their power from the fission of enriched uranium. Other space missions were powered by the heat caused by the natural decay of other radioactive materials (i.e., Plutonium, Polonium, Cerium and Strontium).[520]

The one and only claim in the 35 years since the signing of the *Liability Convention* was made following the uncontrolled landing on the Earth of a nuclear-powered satellite. On 24 January 1978, the USSR's Cosmos 954 satellite re-entered the Earth's atmosphere in Canadian air space. As Canada stated in its claim to the USSR, "[o]n re-entry and disintegration, debris from the satellite was deposited on Canadian territory, including portions of the Northwest Territories, Alberta and Saskatchewan."[521]

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[518] Klinkrad, *supra* note 511 at 271.

[519] *Ibid.* at 286.

[520] *Ibid.* at 285.

[521] Canada's Statement of Claim, Claim against the Union of the Soviet Socialist Republics for Damage Caused by Soviet Cosmos 954, dated 23 January 1979, annexed to a note from Mark MacGuigan, Secretary of State for External Affairs to Soviet Ambassador Alexander N. Yakovlev, 18 I.L.M. 899 at 902 (1979).

Particularly alarming in this case was the fact that Cosmos 954 carried a "nuclear reactor working on uranium enriched with isotope of uranium-235."[522] In total, eleven pieces of this satellite were discovered—all but two of them were radioactive—some of them to a lethal degree.[523] Canada estimated its cleanup costs at nearly $14 million, claimed $6 million[524] and settled for $3 million.[525]

Following the Cosmos 954 incident, the United Nations passed a General Assembly resolution entitled, "Principles Relevant to the Use of Nuclear Power Sources in Outer Space."[526] This resolution restricted the use of nuclear power sources in space "to those missions which cannot be operated by non-nuclear energy sources in a reasonable way."[527] It specifically limited the use of nuclear reactors in space to interplanetary missions, high orbits, or Low Earth Orbit "if they are stored in sufficiently high orbits after the operational part of their mission."[528]

Despite the General Assembly resolution, nuclear power sources in space remain a concern. Around 150 kg of the extremely long-lived decaying nuclear material (i.e., Plutonium, Polonium, Cerium and Strontium) and about 1,000 kg of uranium nuclear

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[522] *Ibid.*

[523] *Ibid.* at 904 and 922.

[524] The actual figures were $13,970,143.66, $6,041,174.70, and $3,000,000 respectively. *Ibid.* at 904.

[525] The $3 million dollar settlement was finally negotiated two full years after Canada presented its claim. The settlement did not even formally acknowledge the USSR's legal liability. Schwartz, Bryan & Berlin, Mark L. "After the Fall: An Analysis of Canadian Legal Claims for Damage Caused by Cosmos 954" (1982) 27 McGill L.J. 676, 678.

[526] *Principles Relevant to the Use of Nuclear Power Sources in Outer Space,* GA Res. 47/68, UN GAOR, 47th Sess., UN Doc. A/RES/47/68 (1992).

[527] *Ibid.* at Principle 3.

[528] *Ibid.* at Principle 3(2)(a).

material is currently in Low Earth Orbit and will remain radioactive long after it has fallen back to Earth.[529]

Arguably more significant than the danger debris can cause on Earth is the danger debris poses to other space objects. With this in mind, a discussion of the potential for debris to damage other space objects is in order.

C. Damages Caused in Space

For damages in space, the *Liability Convention* holds a State liable only if it was at fault for the damage caused. Specifically, a State is liable for such damage "only if the damage is due to its fault or the fault of persons for whom it is responsible."[530] Hence, recovery under the *Liability Convention* in cases involving damage in space is much more limited than when damage occurs on the Earth.

The obvious problem with debris remaining in orbit is that, traveling at speeds of up to 10 km/s, any collision with a piece of debris larger than 1 cm could destroy a satellite.[531] In fact, at 10 km/s, a mere 1-gram particle would collide with equal energy as a 1-ton car driving approximately 36 km/h.[532] This is especially alarming when considering manned spacecraft, like the International Space Station or the Space Shuttle. The International Space Station, though it is the most heavily shielded spacecraft ever flown is only shielded to withstand collisions with debris no larger than 1 cm.[533]

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[529] Klinkrad, *supra* note 511 at 285. See also Williamson, *supra* note 500 at 55.

[530] *Liability Convention*, *supra* note 420, art. III.

[531] "Objects larger than 1 cm can produce catastrophic damage." U.S., *Interagency Report*, *supra* note 485 at 8.

[532] To calculate the kinetic energy at impact is a simple equation: ½ mv^2 (where "m" = the mass of the object and "v" = the velocity, or speed at which the object is moving). Williamson, *supra* note 500 at 50.

[533] "Orbital Debris: Frequently Asked Questions," online: NASA Orbital Debris Program Office <http://www.orbitaldebris.jsc.nasa.gov/faqs.html#7> (accessed 18 June 2007).

Hopefully it won't ever collide with one of the estimated 40,000 pieces of debris between 1 cm and 10 cm in size resulting from the 2007 Chinese ASAT test. Prior to the creation of this massive amount of new debris, the probability that the International Space Station would collide with a piece of debris larger than 1 cm was about 6 percent over the course of its estimated 30-year lifespan.[534] As more and more debris continues to be created in Low Earth Orbit, probabilities for catastrophic collisions will only grow worse. An object having a cross sectional area of 100 square meters (including solar panels) and orbiting in Low Earth Orbit at 400 km, would hit a piece of debris larger than 10 cm only once every 15,000 years.[535]

In contrast, the chance for any particular satellite in Geostationary Earth Orbit to collide with a piece of debris in any given year is about one in a million.[536] That said, some view the problem of debris in Geostationary Earth Orbit to be even more significant than debris in Low Earth Orbit since that debris will remain in orbit for over a million years.[537]

The risk doesn't sound so intimidating when considering the odds of collision with a particular satellite in a particular year. It becomes substantial, however, when you consider the probability for a destructive collision among the entire population of active

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[534] Thomas Beer, "The Specific Risks Associated with Collisions in Outer Space and the Return to Earth of Space Objects—the Legal Perspective" (2000) XXV Air & Space L. 42 at 44.

[535] "Space Debris: accessing the risk" (16 March 2005), online: European Space Agency <http://www.esa.int/esaCP/SEMZL0P256E_FeatureWeek_0.html> (accessed 20 June 2007).

[536] Williamson, *supra* note 500 at 51.

[537] "[T]he orbiting objects in [Geostationary Earth Orbit] will remain there for tens of millions of years, i.e., for ever. Thus, they pose a threat to space operations in that orbit." Ram Jakhu, "Space Debris in the Geostationary Orbit: Implications for Commercial Space Activities" (Paper presented to the Second Space Law and Policy Symposium, Tokyo, Japan, 26 February 1991).

satellites. "If you calculate the combined profile area of all satellites in orbit, you find that the average time between destructive collisions is about 10 years."[538]

One famous collision was between the U.S. Space Shuttle and a fleck of paint smaller than .01 cm. The paint chip seriously damaged the window of the Space Shuttle.[539] This tiny collision was not, however, a one time occurrence. In the first 70 flights of the Space Shuttle, the window had to be replaced 60 times due to high-speed impacts with objects the size of a grain of salt (sub-millimeter).[540] The risk to the Space Shuttle from critical penetration by space debris has been calculated at "about 1 in 250 for a typical mission to the International Space Station, which makes orbital debris the single largest threat to Shuttle operations from launch to landing."[541]

Another frequently cited example of damage caused by space debris is damage to the Hubble Space Telescope. In 1993, during the first servicing mission to the Hubble Space Telescope, a hole measuring over 1 cm was found through an antenna mounted to the telescope.[542] A solar array returned from the Hubble Space Telescope, after three and a half years in space revealed an astounding 150 complete penetrations.[543]

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[538] "Space Debris: accessing the risk" (16 March 2005), online: European Space Agency <http://www.esa.int/esaCP/SEMZL0P256E_FeatureWeek_0.html> (quoting Heiner Klinkrad, Senior Mission Analyst for the European Space Operations Centre)(accessed 20 June 2007).

[539] "Calculations showed that a 0.2-mm paint fleck, traveling at a relative velocity of between 3 and 6 km/s, produced the 4-mm-diam crater." Williamson, *supra* note 500 at 64.

[540] U.S., *Interagency Report*, *supra* note 485 at 24.

[541] Williamson, *supra* note 500 at 64.

[542] "Space Debris: accessing the risk" (16 March 2005), online: European Space Agency <http://www.esa.int/esaCP/SEMZL0P256E_FeatureWeek_0.html> (accessed 20 June 2007).

[543] Williamson, *supra* note 500 at 61.

In July 1996, the French microsatellite Cerise was hit by a piece of debris from an Ariane rocket's third stage (a French rocket) that had exploded 10 years earlier.[544] The debris from the Ariane completely severed the satellite's gravity stabilization boom, though, remarkably, the satellite continued to function.[545] This was the first time two catalogued pieces of debris had ever hit each other.[546]

The debris problem is real. Satellites do get impacted by man-made debris. One expert estimates that all satellites get hit by tiny pieces of debris every day.[547] Applying the *Liability Convention* to a case involving the destruction of a satellite in space is doubtful. First, unless the collision happens to be between two catalogued space objects, it is doubtful that the injured party would be able to attribute the offending debris to any particular State. Anything larger than 1 cm is large enough to destroy today's most heavily protected spacecraft—the International Space Station.[548] Most debris that is large enough to destroy a satellite is too small for even the best of today's equipment to track (smaller than 10 cm). A State might not even know why its satellite ceased functioning—it may be uncertain whether its satellite was hit by a piece of debris or whether it had some type of internal malfunction. Hence, proving that a particular State caused damage to another State's satellite is unlikely. Second, even if the debris were attributed to a State, in order to recover damages for the loss of a satellite, it would have

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[544] *Ibid.* at 66.

[545] *Ibid.*

[546] *Ibid.* at 67.

[547] *Ibid.* at 66.

[548] "Orbital Debris: Frequently Asked Questions," online: NASA Orbital Debris Program Office <http://www.orbitaldebris.jsc.nasa.gov/faqs.html#7> (accessed 18 June 2007).

to prove fault (negligence) of the State whose debris struck its satellite.[549] Because of these difficulties, any recovery via the *Liability Convention* for damages caused to a State's space objects is unlikely.

D. Due Regard and Appropriate International Consultations

Article IX of the *Outer Space Treaty* provides, in relevant part:

> In the exploration and use of outer space, ... States Parties to this Treaty ... *shall conduct all their activities in outer space, ... with due regard* to the corresponding interests of all other States Parties to the Treaty.... If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, ... would cause potentially harmful interference with the activities of other States Parties in the peaceful exploration and use of outer space, including the moon and other celestial bodies, *it shall undertake appropriate international consultations before proceeding* with any such activity or experiment.[550]

This article applies to ASAT use in two respects. First, all States are bound to conduct "all of their activities in outer space" (including ASAT tests) with "due regard" for the interests of all other States that are Party to this treaty. What constitutes "due regard" is not defined in the *Outer Space Treaty*. It is a phrase that has common meaning, however. "Due" generally means "[j]ust, proper, regular, and reasonable".[551] "Regard" generally means "[a]ttention, care, or consideration".[552] It is hard to imagine how in most cases, conducting an ASAT test that caused considerable debris could possibly be done with "due regard" for anyone but one's own State.

Furthermore, it is clear that "appropriate international consultations" are required *before* a State does something that "would cause potentially harmful interference" with

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[549] *Liability Convention*, *supra* note 420, art. IV(1)(b).

[550] *Outer Space Treaty*, *supra* note 48, art. IX [emphasis added].

[551] *Black's Law Dictionary*, 8th ed., *s.v.* "due".

[552] *Ibid.*, *s.v.* "regard".

the activities of other States. Due to the large amount of debris that is created in space when some ASATs are employed, it is likely that the above provision of the *Outer Space Treaty* will apply. The word "harmful," is not defined in the *Outer Space Treaty*. This is unfortunate, but consistent with the wide range of other terms used in the *Outer Space Treaty* that were never defined.[553] That said, when an ASAT creates an estimated 40,000 pieces of debris large enough to destroy spacecraft—that will be whizzing around in orbit for around 100 years—the only reasonable conclusion is that this will cause "potentially harmful interference" with the satellites (current and future) that share this orbit. International consultations are therefore required before ASAT tests like the one conducted by China in January 2007.

The requirement for consultations would not, itself, prohibit any ASAT tests, regardless of how much debris the test would cause. During "appropriate international consultations," however, States would have the opportunity to express how a planned activity would not show them the "due regard" they are owed. Due regard, should not be considered as having been satisfied merely because a State has conducted the "consultations."

Most recently, China neither showed "due regard" to all of the other States operating satellites in Low Earth Orbit, nor did China engage in any international consultations whatsoever prior to launching their January 2007 ASAT test. Hence, China violated both of these requirements of article IX of the *Outer Space Treaty*.

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[553] Other terms used in the *Outer Space Treaty* that lack definitions (and have caused considerable consternation to space lawyers) include the terms: "space," "peaceful," "weapons of mass destruction," "use," "astronauts," "international responsibility," "authorization and continuing supervision," "component parts," "launches," "procures," "cooperation," "appropriate measures," and "appropriate international consultations."

E. Environmental Modification Convention

The Environmental Modification Convention (*ENMOD*)[554] also arguably applies to ASAT weapons. It prohibits States from engaging "in military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to any other State Party."[555] *ENMOD* specifically notes "'environmental modification techniques' refers to any technique for changing—through the deliberate manipulation of natural processes—the dynamics, composition or structure of the earth ... *or of outer space*."[556]

One kinetic-energy ASAT can cause thousands of pieces of debris that can remain in orbit for long periods of time—decades in Low Earth Orbit, basically "forever" if such an ASAT were ever used on a satellite in Geostationary Earth Orbit. Arguably, since the signing of *ENMOD* in 1977, the U.S., Russia, and most recently, China, have all violated the terms of *ENMOD*. All of these States have used military techniques that cause "widespread, long-lasting" effects to the space environment.

To sum up this Chapter, debris in space comes from a variety of sources. ASAT use, notably the use of kinetic-energy ASATs, creates a large amount of this debris. The amount of debris in orbit is growing. Debris travels so fast that even pieces no larger than a pea can destroy spacecraft, and at times, larger pieces fall back to Earth, putting

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[554] *The Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques*, 18 May 1977, 1108 U.N.T.S. 151 [*ENMOD*]. This treaty entered into force on 5 October 1978 and has been ratified by 72 States (notably including the U.S., China, Russia, the U.K., and North Korea). Notably, France and Iran are not party to *ENMOD*. "Status of Multilateral Treaties Deposited with the Secretary-General," online: United Nations Treaty Collection online: United Nations Treaty Collection <http://untreaty.un.org/ENGLISH/bible/englishinternetbible/partI/chapterXXVI/treaty1.asp> (accessed 24 May 2007).

[555] *ENMOD*, *supra* note 554, art. I(1).

[556] *Ibid.*, art. II [emphasis added].

objects on Earth at risk. The *Liability Convention* was created to address the issue of damage caused by space objects. While it has been invoked on only one occasion, the likelihood of damage caused by debris is growing. Two other treaties also have provisions relating to creation of debris—the *Outer Space Treaty* and *ENMOD*.

Pursuant to the *Outer Space Treaty*, States should avoid unnecessarily creating debris out of "due regard" for the outer space activities of other States. States are also required to conduct "appropriate international consultations" prior to activities in space that will "potentially" cause harmful interference with the activities of other States. Creating large amounts of dangerous debris should qualify as such potentially harmful interference. Finally, the provisions of *ENMOD* also apply to outer space activities. *ENMOD* prohibits States from using military techniques in ways that will have "long-lasting or severe effects" on the environment. ASAT use creates such damaging and long-lasting effects in outer space.

The concern with space debris is serious. Were States to employ debris-creating ASATs in a conflict, a consequence would certainly be a dramatically more hazardous and less useable environment in space. This danger, combined with the concerns over turning space into a battlefield, lead to the final discussion—the desirability of restricting ASAT use via an international treaty.

Chapter Six: A Treaty Banning ASATs

A. Desirability of a Treaty Restricting ASATs

The values of ASATs are rather straightforward. If a State can negate an adversary's space capabilities (communications, navigation, reconnaissance, and even weather), while maintaining its own space capabilities, it will have a significant military advantage. On the flip-side, if a State is facing an enemy with a significant military advantage due to its opponent's space assets, use of ASATs would decrease this advantage, as previously noted, in "a non-linear degradation—one approaching an order of magnitude reduction in capability."[557] ASATs could also act as a deterrence to war—as uncertainty over the ability to effectively employ military satellites against a potential enemy may factor into a decision on whether or not to go to war.[558]

The problems of ASATs are equally straightforward. First, States want to ensure vulnerable and increasingly valuable (militarily, economically and even socially) space assets are safe (from direct attack and also from indirect damage). Second, some satellites serve important conflict prevention purposes (e.g., early warning satellites and those used for arm control verification). Continued access by both sides of a potential conflict to these satellites serves to preserve peace, or at least avoid escalation to a nuclear conflict.

Hence, on the one hand, a State wants to be able to threaten a potential opponent's satellites (especially those that will seriously enable the opponent's military) and on the other hand, it would be advantageous to have assurances that potential enemies would not

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[557] Shields, *supra* note 256 at 6.

[558] U.S., *Policy on ASAT Arms Control*, *supra* note 213 at 16.

attack your own satellites—even though they provide incredible advantages in any conflict. Logically, the exchanged promise, "I won't hurt your space assets if you won't hurt mine" would most favor the States with the most space assets. Hence, it would seem logical that the U.S. would be extremely interested in this sort of an agreement (especially if there were measures in place to ensure compliance). A potential problem requiring consideration, however, is that any BMD plan that includes attacking missiles while transiting space would also have inherent ASAT capabilities. If a BMD program is perceived as vital to a State's security, then any agreement restricting ASATs may have to specifically allow for the BMD program.

It comes down to a judgment call over which is most important to a State:

a. The ability to destroy the satellites of enemies (in self-defense); or

b. Keeping space assets free from attack (assuming enemies also obey the law).

Of course, having an agreement won't necessarily prevent a State from attacking another State's satellites. But if proper verification measures[559] are employed, States can have some confidence that its space assets will be safe. Problems with verification have, in fact, been largely responsible for past failures to reach ASAT arms control agreements.[560] If this continues to be an irreconcilable problem, one solution would be to merely ban whatever ASATs can be verified.[561]

President Reagan's policy on ASAT arms control correctly observed, "possible limits or bans on anti-satellite (ASAT) arms must be judged not only in their ability to

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[559] E.g., one space law expert posited, "by far the most effective and most reliable [verification measures] would be on-site, pre-launch inspections of all objects, both civilian as well as military, destined for outer space." Vlasic, *supra* note 455 at 52.

[560] U.S., *Policy on ASAT Arms Control*, *supra* note 213 at 22-23.

[561] Carter, *supra* note 240 at 96.

limit damage to space objects, but also in their contribution to achieving the basic objectives of arms control with respect to terrestrial conventional and nuclear conflict."[562]

With this in mind, States need to determine whether ASATs, or systems with ASAT capabilities (e.g., space-based BMD), will prevent or provoke conflict. States must balance whether ASATs make their satellites safer or, on the contrary, more vulnerable. The U.S., through its partially-space-based BMD program, would like to change its position from "mutually assured destruction" to "assured survival."[563] The BMD program, with its ASAT capabilities, besides being incredibly expensive,[564] has only dubious chances at success.[565] Given this, the U.S. will have to determine whether it is worth initiating a possible nuclear confrontation with Russia or China in order to field a BMD system in space.

In light of Russian President Vladimir Putin's warning of "nothing less than the beginning of a nuclear era"[566] it appears that new space-based weapons (including, perhaps, some aspects of BMD) could instigate, rather than prevent the escalation of hostilities—up to and including nuclear war. This is not something to glibly ignore.

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[562] U.S., *Policy on ASAT Arms Control*, *supra* note 213 at 17.

[563] Graham, *supra* note 243 at 103.

[564] The anticipated cost of a space-based BMD is estimated at $16.4 billion. Independent Working Group, *supra* note 134 at 107.

[565] Fred Kaplan, "Shooting Down Missile Defense: Even the Pentagon Admits the Program is in Trouble", online: (7 August 2003) *Slate Magazine* <http://www.slate.com/id/2086724> (accessed 5 July 2007).

[566] *Statement of Russian Ambassador on PAROS*, *supra* note 361 (quoting President Vladimir Putin).

B. The Prospects for the Treaty

The prospects are grim for any new international agreement limiting ASATs. The U.S. (at least the Executive Branch) is against creating any new international agreements relating to space law. The *2006 National Space Policy* is explicit on this matter:

> The United States will oppose the development of new legal regimes or other restrictions that seek to prohibit or limit U.S. access to or use of space. Proposed arms control agreements or restrictions must not impair the rights of the United States to conduct research, development, testing, and operations or other activities in space for U.S. national interests ....[567]

This position was affirmed by U.S. Ambassador Rocca at the Conference on Disarmament in February 2007, "[d]espite this long-standing and effective international space treaty regime, centered on the Outer Space Treaty, there are those who advocate negotiating new multilateral agreements that we believe to be unnecessary and counterproductive. We do not need to enter into new agreements."[568]

Combined with the 2002 withdrawal from the 1972 *Anti-Ballistic Missile Treaty*, and the U.S. pursuit of a ballistic missile defense system, the prospects for a treaty restricting ASATs look grim. That said, the actual weaponization of space has not yet begun. As such, it is not too late to return to the negotiating tables and seek to work out an agreement that would be satisfactory to all parties.

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[567] U.S., *2006 National Space Policy*, *supra* note 126 at 2.

[568] "Statement of Ambassador Rocca on PAROS", *supra* note 316 at 4.

Chapter Seven: Conclusions and Recommendations

Space assets are increasingly valuable. Satellites make military forces vastly more effective than ever before. Satellites are also commercially successful—currently a $200 billion dollar industry and still growing. ASAT weapons are the natural enemies of all satellites. ASATs come in the form of nuclear weapons, kinetic-energy weapons, direct-energy weapons and electronic jamming weapons. They also include BMD programs, which have inherent ASAT capabilities. A growing number of States have ASAT capabilities and some ASAT capability could effectively be employed by terrorists. While some measures may be employed to increase the "survivability" of satellites—such as hardening, maneuvering out of the way of incoming satellites, or using "stealth" capabilities—these measures cannot adequately protect satellites from the wide variety of ASAT threats.

The U.S., China and Russia have all demonstrated their intentions to use ASAT weapons. The U.S. has done so via its published military doctrine, its national space policy and its continued funding for "space control" and BMD. The U.S. withdrawal from the *Anti-Ballistic Missile Treaty* in 2002 and its vote against the PAROS resolution also bode ill for the future of ASAT arms control. China and Russia, though less transparent, and in fact, publicly opposed to ASATs, have both demonstrated some intent to use them. China has demonstrated this most recently by its recent laser and kinetic-energy ASAT tests. Chinese military doctrine also discusses the use of ASATs in any conflict over Taiwan. Russia, though still observing its moratorium on ASAT use, retains its ASAT capability and has publicly threatened nothing less than nuclear war in the event the U.S. proceeds with space-based weapons.

Though the UN Charter currently bans the use of force, or even the threat of force, the exception for self-defense has been broadly interpreted by the U.S. LOAC applies to any conflict in outer space. Under LOAC, most satellites, even commercial ones, will be considered valid military objectives. One LOAC problem will be the difficulty of avoiding indirect damage to the satellites of neutral States when attacking the satellites of a belligerent. In spite of lofty statements regarding preserving space from war, space is already heavily militarized and will likely be weaponized as soon as the U.S. begins its space-based BMD. This weaponization will likely spark not merely a space-race but a war. Several treaties contain provisions relating to arms control in space. In 2002, however, the U.S. withdrawal from the *Anti-Ballistic Missile Treaty* was a setback to the goal of keeping space free from weaponization.

Another substantial concern with ASAT use is the enormous amount of debris many ASATs generate. This debris, in turn, threatens the future use of space for centuries. The *Liability Convention* provides for financial recovery for States who suffer damage caused by space objects (including debris). Perhaps more significantly, the *Outer Space Treaty* requires States to conduct their activities in space with "due regard" for the space activities of other States—this requirement should prevent States from unnecessarily exploding ASATs. Provisions mandating "appropriate international consultations" should provide States the opportunity to express how planned ASAT tests would not show proper "due regard" for their space activities. Finally, the *ENMOD* treaty also has provisions which should be read as prohibiting the use of many types of ASATs.

A treaty restricting ASAT use would provide protection for satellites and preserve the use of space for future generations. Prior attempts at negotiating such a treaty have been unsuccessful. The Executive Branch of the U.S. has expressed a total lack of interest in trying to come to an agreement limiting ASATs.

Has the U.S. lost faith in the ability of laws to help maintain peace? Would the U.S. rather rely solely on its military might to combat threats to both the U.S. and its space assets? If so, Thomas Paine's famous quote, "in America THE LAW IS KING"[569] is in danger of becoming merely "America IS KING." It is not too late, however, to return to the table of diplomacy. Like all international agreements, creating an ASAT treaty will require some give and take. In so doing, we will preserve the future of space—and perhaps more.

[569] Thomas Paine, *Common Sense* (Edinburgh, 1776) at 55 (emphasis in original).

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